A HANDBOOK OF CHILD PSYCHOLOGY

SECOND EDITION
REVISED

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PREFACE TO THE SECOND EDITION

Within a period of slightly more than two years, this first revision bears scarcely any resemblance to the original "Handbook of Child Psychology." This is due chiefly to the great expansion of the field during the last three years and partly to the improved insight of the Editor. Chapters on topics not subjected to continued research have been omitted. Perhaps the most important recent development has been the renewed interest in the study of prenatal behavior and the behavior of the neonate. Research workers have changed the Editor's mind concerning certain restrictions, and the boundaries of the volume have been extended.

It was hoped that it would be possible for the volume to carry a chapter on nutrition and disease as factors in the development of child behavior, but it has been found that those factors are not yet sufficiently understood to warrant inclusion in a scientific handbook of this type. It has also been hoped that there could be a chapter on sensory and motor defects as factors in the development of child behavior, but the person who agreed to write that chapter found it impossible to complete the task. The elimination of the above two deficiencies would seem to be the chief goal for the next edition.

There has been no attempt to simplify, condense, or to appeal to the immature mind. This volume is prepared specifically for the scholar, and its form is for his maximum convenience.

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PREFACE TO THE FIRST EDITION

The field of child psychology is almost as old as is the field of experimental psychology. Experimental psychology has had a much older scientific and academic status, but at the present time it is probable that much less money is being spent for pure research in the field of experimental psychology than is being spent for pure research in the field of child psychology. In spite of this obvious fact, many experimental psychologists continue to look upon the field of child psychology as a proper field of research for women and for men whose experimental masculinity is not of the maximum. This attitude of patronage is based almost entirely upon a blissful ignorance of what is going on in the tremendously virile field of child behavior. The time is not far distant, if it is not already here, when

nearly all competent psychologists will recognize that one-half of the whole field of psychology is involved in the problem of how the infant becomes an adult psychologically.

It is believed that a proper and systematic presentation of the problems of child psychology, presented as problems experimentally investigated, will demonstrate a field of scientific research surprisingly full of accomplishment and of promise even to some of the experts in the field itself. The main reason for this surprise is that most of the books in child psychology have been either highly specialized monographs or highly popularized elementary textbooks. There has not yet been a single volume treating the entire field of child psychology which could be useful to students already acquainted with psychology and already expert in child psychology.

In the preparation of this volume, as in previous similar tasks, we have faced the difficulty of having to determine the limits of the field. In the minds of some, an obvious omission is a chapter on the delinquent child. We simply are not certain whether such a chapter should be included or not. There is no similar chapter in the advanced textbooks on adult psychology. The question is raised whether delinquency is a psychological problem at all or whether it is a purely social problem, belonging to the fields of education, sociology, and politics. We hope the matter will be discussed and that we may be advised before the next edition goes to the press.

Some may feel also that there should be more than one chapter dealing with the psychoanalytic approach to an understanding of child behavior. One adviser has suggested that there should be a chapter dealing with the identification of analytic entities in the young child, with the possible heredity of such entities, and with their neurological correlates. It is admitted, however, that such a chapter lies well out in the future.

The Editor wishes to express warm appreciation to the authors of the various chapters in this volume, who have sacrificed from their busy professional lives the time necessary to perform the labor involved in the preparation of this handbook. He wishes also to express his gratitude to Dr. Luberta Harden for her preparation of the manuscripts for the printer and for the making of the indices.

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INTRODUCTORY

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THE METHODS OF CHILD PSYCHOLOGY

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In the history of any science there can be discerned two trends, one consisting of the facts and generalizations, slowly but surely accumulated, which in the course of time become welded into a substantial and integrated field of knowledge, and the other of the methods and techniques by means of which problems are attacked. A discussion of method resolves itself ultimately into a discussion of the techniques available for the solution of particular problems and of the criteria slowly evolved by a science for the evaluation of its own techniques. Problems, techniques, and results cannot be sharply differentiated. A problem, however stated, does not become a scientific problem until a method of attack can be set up. Results, in their turn, depend upon technique, and other problems put in their appearance only as technique and results move forward.

As we look upon a science from the standpoint of its content, we are impressed by the uneven manner in which both the various sciences, compared one with another, and the various fields within a given science are developing. With the appearance of a method or technique that holds promise, one aspect of a science may spurt forward rapidly and engross many workers, while another remains relatively inactive. Far from being a well-ordered, uniformly growing body, a science is composed of many parts which grow at different rates and reach maturity of method at different times. This seems to be particularly true of psychology, which faces problems and interrelations of extraordinary complexity. Instead of advancing on one front with a single and highly efficient weapon, we seem to be advancing on many fronts with a variety of weapons. But advance in method is usually marked by progress from simple description to precise formulation of relations and principles in quantitative terms.

The history of science shows that each field of human knowledge begins with relatively simple techniques based on the common, everyday observation of phenomena, and proceeds, as a clearer conception of the nature of scientific method is developed, to forge new weapons and techniques. A technique which in one generation constitutes the best weapon available for attacking a problem may in another generation become obsolete. At the same moment in any science some problems are susceptible of attack only by the simplest methods, while others can be attacked only by more complex and involved methods. It little behooves us, then, to place a method or technique in a mid-Victorian classification of right or wrong. Rather should the critic demonstrate how, in attacking a particular problem, a better method could have been used.

For a long period of time the child was almost completely neglected by the experimental psychologists. Child psychology had no place in an approach that sharply limited psychology to the results of the application of a particular method under limited conditions to trained adult observers. Early developments in the study of the child occurred somewhat without the pale of orthodox psychology. The child was accepted as an adequate subject for psychological investigation only in recent times under the influence of a broadening conception.

Evolution of Method in Child Psychology

If we turn to the early philosophical writings, we find occasional speculations and observations on children. A classical example is to be found in Plato (21), who recognizes the existence of individual differences, builds up a theory of the state in which these differences are utilized, makes suggestions regarding tests of fitness, and even proposes to modify training by supervising nursery tales. With Rousseau (25) and Locke (14) generalizations of importance in their systems of thought are drawn from conceptions of the nature of infancy and childhood.

In the nineteenth century, so notable for its advance in all fields of science, a few individuals made observations upon children in a fairly systematic fashion. The biographical method developed involved the day-by-day recording of the events as they took place in the life of the child. Often simple experiments and measurements are included. The number of such biographies now available, both published and unpublished, is considerable. Among the outstanding ones may be mentioned those of Preyer (24), the Sterns (28, 29), Shinn (27), and the Scupins (26).

With the turning of the attention of G. Stanley Hall toward the child, a new method, the questionnaire, put in its appearance. Starting with Hall's (12) inquiry into the "Content of Children's Minds," there came a deluge of questionnaires which resulted in the accumulation of a great mass of material about children, particularly during the school ages. The results were a substantial advance in our knowledge of children, the training of a number of capable students of child behavior, and the setting of the stage for the marked development which was to take place some years later.

With the work of Gilbert (9), systematic tests of school children were undertaken, and the movement later to result in the development of educational psychology was under way. Binet (1*a*) forged the new method of intelligence testing following the turn of the century, after extensive researches dating back to the nineties and even earlier. A tremendous advance was made in the study of children, and psychology speeded on its way, working out the possibilities of the new method. To the Binet tests modern students of child psychology owe a great debt. Following their development there appeared a number of other techniques, such as rating scales, and measures of achievement, which have made substantial contributions.

Experimental child psychology can be dated in large measure from the works of Thorndike (32) and Watson (34). For both, a genetic approach is essential. For both, the crucial observations for a systematic approach are made upon children rather than upon adults. Further, Watson's emphasis upon objectivity of method and his dismissal of introspection made children quite as adequate subjects for psychological investigations as adults.

A somewhat different line of development is followed by the case-history method. For many years, even antedating the biographical studies of children, there are to be found in the medical literature clinical notes or descriptions of cases of defective, abnormal, unusual, or diseased children. These clinical notes, with such supporting material as could be obtained, are the forerunners of the social case history developed by the agencies concerned with the practical handling of children. With the advent of psychoanalysis, accounts of the development of the individual from early childhood, as obtained through the process of free association or analysis in the adult, make their appearance.

Evolution of Method in Human and Animal Psychology

In contrast with the development in child psychology, which started with incidental observations and moved through a period of biographies and systematic observations to the development of experiments, tests, and rating devices, we find that in general psychology a jump was made directly from speculation and incidental observation to experiments. The new science of psychology borrowed its methods directly from the physical and physiological sciences, and patterned its techniques as closely as possible upon those sciences. The restriction of investigations to the laboratories and the emphasis upon introspection left children, animals, and abnormal individuals outside the field of psychology. An exception is found in Galton, who employed the questionnaire and made many observations which could hardly be called experimental in the laboratory sense. Although some work was done in testing adults in the early nineties by Cattell and his associates, the test and rating techniques in the main came into adult psychology from child psychology. The case history, which followed a more or less independent line of development, reached its greatest importance chiefly in those fields from which experimental psychology was excluded by definition.

In the field of animal psychology, incidental observations were followed by systematic observations, which were followed in turn by experiments. Tests, questionnaires, and ratings lie outside the field of the animal psychologist because of the nature of the material with which he works. Methods analogous to the case history and the biography have been used rarely and then only for such outstanding performers as Clever Hans and occasional primates.

The Introspective and the Behavioristic Approaches

Perhaps the differences between the development of child and animal psychology, on the one hand, and adult psychology, on the other, can be explained by the fact that adult psychology took over its method from sciences already well advanced on the road from incidental observation to experiment, whereas child and animal psychology were under the necessity of forging their weapons as they went along. In their zeal for experimentation, the early psychologists found in introspection an approach which much more readily permitted adaptation to laboratory conditions than did the observation of behavior.

In the literature on child psychology there are few discussions concerned with the difference between these two approaches, whereas in general psychology the controversy over their relative merit has at times assumed large proportions.

In brief, this controversy arises out of the existence of two sources of data, the first of which is found in the individual's own inner experience and can be described only by the individual himself, and the second of which is to be found in the observations which can be made on overt behavior. Both types of data can be elicited under experimental conditions. Dismissing the problem raised by the existence of two kinds of data as not arising in child psychology is too simple a solution. Koffka (13) has recently attacked this problem at some length. He distinguishes between *"actual or real facts"* which can be determined by any person, which are susceptible of measurement and quantitative treatment, and which give rise to "functional concepts," and "experiences," or *"phenomena"* which can be described only by a single person, which are qualitative in their nature, and which give rise to descriptive concepts. On the basis of this analysis he arrives at three methods, the first of which is called the "natural-scientific method," which consists in observing the individual in situations and recording only the behavior of the individual. The second is the "psycho-physical method" in which both behavior and description or introspection are used; and the third, or purely psychological, method is that in which introspection alone is used. Koffka goes on to point out that in child psychology, despite its apparent objectivity and use of the "natural-scientific" method, it is necessary, in order to obtain a scientific understanding of the objective behavior, to consider the psychological aspects of infantile behavior and to be prepared to employ descriptive concepts without the aid of any direct report of the child's experience. In order to accomplish this end, a "psychological talent," which constitutes a special form of the purely psychological method, is used.

> "With the aid of this talent we must try to put ourselves in the place of the child with the same tasks before us which the child is expected to solve and with only those means at our disposal which are available to the child. In this way we can endeavor to determine the characteristic phenomena occurring under these conditions. As a

working hypothesis we may therefore assume that similar phenomena are present in the mind of the child though we may then have to verify this hypothesis indirectly by means of objective tests of behavior" (13, p. 31).

An inference from the Koffka analysis is that, no matter how objective our approach to the child, both the categories and the interpretations of those categories come from adult psychology to child psychology rather than the reverse. In recent years among students of child psychology emphasis has been placed upon the opposite point of view. It is held that, by securing the facts of child development impartially and objectively, adult psychology will be reinterpreted and become more adequate. Although the problem here involved must wait upon the further progress of the science, many psychologists feel that up to the present time there has been so much interpretation of the phenomena of child behavior in terms of adult life that it may be more worth while, for a time at least, to approach child psychology in and for itself, without any particular reference to adult processes. But Dunlap (5), who clearly states the problem involved here, has a different point of view. He says:

"Child psychology, for example, the study of the child mind, is to a large extent an interpretation of the activities of the child in terms of adult psychology and therein lies both the possibility and the danger of child psychology." *The danger in child psychology* . . . . "results from the great difference in the behavior of children as compared with the human adults under the same circumstances although certain outstanding details of the behavior may be the same in the two cases. The danger therefrom is in inferring that the child's mental processes are the same as those of a human adult under similar circumstances through failure to note that the child's reactions are not really the same as, those of the human adult. The actual determination of the behavior of children and animals is far more difficult than the determining of the behavior of adults. It has been assumed sometimes that the child mind may be examined without reference to the adult mind and therefore without the disadvantage of the source of errors in such a comparison. This assumption is an unfortunate mistake which has merely served to cover up arbitrary assumptions as to the child's mind. One might indeed study child behavior exclusively, but when one discusses perception, thought, and emotional experience in children, one is making inferences from the adult mind; so that the only safety lies in being thoroughly cognizant of them as inferences. To deny in such cases that one is making inferences is really to refuse to examine one's inferences; a procedure which leads to serious blunders in theory and in the interpretation of experiments" (5, p. 16).

Normative and Experimental Approaches

Whatever view is held upon the question whether child psychology grows out of adult psychology, or the reverse, the fact remains that the great body of investigations in the child field at the present time are be-

havioristic in their approach. This may in large part be traced to another phase of the problem of method in child psychology. Here again there are two tendencies, one closely identified with the experimental psychologists of the nineteenth century, and the other with the more modern period.

The first, patterning again after physics and physiology, seeks to determine the general laws or fundamental principles underlying mental life and rather naïvely assumes that such laws will be universally applicable at all stages of human development. Undoubtedly some principles apply equally well throughout the phylogenetic and ontogenetic series. Weber's law, for instance, seems to apply to animals, children, and adults. Likewise, researches on animals, children, and adults alike have demonstrated the existence of a principle of the distribution of effort which, while it cannot be so precisely stated as is Weber's law, nevertheless seems to point to an underlying law. Some principles, possibly to be classed as scientific generalizations of a lower level, however, seem to apply to only limited portions of the developmental series—witness the Brian and Goodenough (3) study of color and form preferences in children and adults. Without attempting to decry attempts to obtain general laws, nevertheless it may be well to point out that the determination of the ranges or levels of the developmental series in which principles or laws operate is quite as important scientifically as is the determination of the principle itself within a limited range of development. There is no warrant for assuming that the college or graduate student is the sole representative of humanity for scientific purposes.

The second tendency is concerned with the variability of humans and human behavior and seeks to picture that variability in terms of norms, individual differences, and groups of differences.

In a way, the first approach is related to the introspective point of view, which has tacitly assumed that the protocol of a trained adult observer, under ideal conditions, is interchangeable with that of another trained adult observer. The normative approach bears some relation to the behavioristic point of view. But this identification should not be carried too far. Obviously all science, whether introspective or objective, is concerned with generalization; likewise, since trained observers are far from identical, introspection becomes concerned with differences as well as likenesses.

Within the normative field the great body of researches which at the present time make up child psychology is found. With a developing organism, norms are an essential base upon which psychology must be built. Without them, one is never sure whether the particular phenomena studied are the result of development or the result of the introduction of the artificial conditions so essential to experiment. This results in the appearance of some types of control not found in the ordinary application of experimental technique to problems. The tremendous possibilities of the practical application of norms, once obtained, should not hide the

fact that the study of developmental psychology is more complex than that of adult psychology, and that the normative approach, far from being a pseudo-scientific psychology, is, in the very nature of the case, the basic methodological structure upon which an experimental psychology of the child must be constructed.

If psychology is concerned only with general laws determined upon adults, the normative approach becomes of incidental interest; if psychology has some relation to the whole life of the individual, the normative approach becomes of great importance. Boring says:

> "At any one time a science is simply what its researches yield, and, in the author's view, the researches can be nothing more than those problems for which effective methods have been found. Those who declare that a scientific psychology must undertake the solution of such problems as emotion, thought, will, intelligence, and personality, and that an experimental psychology which does not deal with these problems is not a complete psychology at all,—those persons lose sight of the fact that the research in any science must arise out of available methods" (2, p. 340).

While there should be no unwillingness to accept the principle of defining a science in terms of its researches, one should not forget that one of the outcomes of a narrow definition, insistently maintained, may be the cutting-off of lines of inquiry that may result in the formulation of new methods, and, consequently, the development of a new stream of researches to modify the definition of the science. Certainly, if psychology as a whole has suffered from the fact that it has not had the full-time services of a genius, the field of child psychology has suffered from the fact that it has had so little attention from the able men devoting their energies to a rigidly defined experimental psychology.

Distinction between Sources of Material and Techniques

Before discussing the methods available for the scientific study of the child, a distinction should be made between the raw material of child psychology, the method with which this raw material is approached, and the particular technique or subdivisions of method utilized. By raw material we refer to the mental life and behavior of the child as it issues in more or less permanent form susceptible of subsequent analysis and treatment.

By method is meant a general mode of approach to the raw material, and by technique a specific device for handling material, within the limits of a general mode of approach or method. Thus we speak of the experimental method as denoting the use of artificially controlled situations for the establishment of a general principle, and within that method we speak of the use of nonsense syllables in a study of memory as a technique: or we talk of the test method for the establishment of norms or placing the individual, and, within the test method, of an intelligence test as a tech-

nique, or of a motor test as a technique. In the literature the term *method* is very loosely used; sometimes it refers in the most general way to a field of science, as the "psychological method"; sometimes in a narrower sense, as used here, to refer to a general approach within a scientific field, as the questionnaire method; sometimes to refer to categories which are here called techniques; and sometimes to cut across more general classifications, such as the cross-section method, which indicates a mode of approach that may be used in either the test, the rating, or the experimental method. No completely logical classification of method can be derived; any classification is somewhat arbitrary and is empirically derived from the history of the science. Actually, methods crisscross; for instance, in an experimental set-up we may make use of measurements, tests, and ratings; in a questionnaire, of test results, experimental results, memories, and opinions.

Sources of Material for Child Psychology

An inquiry as to the sources of material in the child's life which may be made the basis for psychological treatment is pertinent. In the following classification the chief sources of material are listed. All sources are susceptible of some scientific treatment, even though they may be of unequal value and require a variety of method.

We may distinguish:

1. *Chronology of events as recorded.* This includes such records as birthday, age of entrance to school, age of passing from one grade to another, etc.
2. *Products of the child, left behind as permanent records.* This includes such permanent products as drawings, letters written by the child, compositions, etc. A variety of techniques can be used in their treatment.
3. *The behavior of the child.* This includes not only observations of behavior as such, but also observations in test or experimental situations devised to predict behavior in general or to establish basic principles or laws. The scientific value of this source of material increases as adequate scientific methods are developed for eliciting and recording behavior under appropriate conditions.
4. *Introspections or verbal reports of the child.* These have been used but little. Perhaps more attention should be paid to this source in order to work out its possibilities.
5. *Memories of the child, or of the adult, of his own child-life.* These are, of course, the property of each individual and vary as to completeness and accuracy in relation to events. They are subject to many errors, both systematic and unsystematic. Modern literature distinguishes two techniques for tapping them, one the recording of conscious memories, and the other getting at more deeply buried memories by a free-association process in one of its variants.
6. *Memories of the child's life as retained by those who have been*

associated with him. Here is included a great mass of the effects left behind by the child in the minds of other people, and more or less adequately retained. These are subject to grave errors, particularly of systematization and incompleteness, but nevertheless constitute a source of material. As the distance in time between contact and reproduction increases, the data become less and less valuable.

7. *Measures of heredity of the child or the environment, culture, or background in which he develops.* Strictly speaking, this source does not furnish direct information on the child. It does, however, supply the data with which the results of observations on the child can be compared. Examples of the use of such accessory data are to be found in the studies of heredity of which the Freeman *et al.* (5*a*) and Burks (4*a*) investigations have attracted the most attention in recent years; the various community studies, in which such matters as the relation of delinquency to city area (Shaw, 26*a*) or intelligence to rural or urban residence (Baldwin, 1) are analyzed; or the many studies of the relation of linguistic development to social level, of which those of Hetzer and Reindorf (12*b*) and McCarthy (15) are examples.

Stern (30), referring to Bühler's study of fairy tales, includes as a source of material children's literature, meaning by this not the products of the child but material prepared by adults for children. This is a minor source, compared with those listed above, and one of somewhat doubtful value unless the reactions of the children to such material are included.

Of these sources, the behavior of the child in situations where some method of recording the behavior is developed and the records of the behavior of the child left behind in his own products offer the major sources for scientific study at the present time. The chronology of events is of relatively little significance except as check material and to furnish a basis for sampling. Introspections of children have been little used. The memories of the child, or of the adult of his own child-life, have been a source in the past, but are less used as more objective methods have been developed for tapping behavior directly. The memories of the child's life retained by others are rarely of scientific significance.

The Methods of Child Psychology

We may now turn to a more detailed description of the methods of child psychology. I have listed fourteen, arranging them roughly in order from simple to complex, from little or no control to maximum control of the factors involved. But the methods do not arrange themselves in a linear series, nor are they mutually exclusive. The methods are:

1. Incidental observation
2. Biography
3. Systematic observation
4. Questionnaire
5. Psychoanalysis

6. Case history
7. Direct measurement and simple tests
8. Tests of complex functions
9. Ratings
10. Experiment
11. Experiment involving random control groups
12. Experiment involving paired control groups
13. Control by statistical devices
14. Factor analysis

I suspect that incidental observation, systematic observation, direct measurement and simple tests, and experiment constitute a series. The biography, questionnaire, and case history are difficult to locate in any series, since they may cover a variety of devices. Psychoanalysis probably is more closely related to the case history than to any other method. The two methods involving control groups may perhaps be looked upon as techniques under the experimental method rather than as distinct methods. The methods of control by statistical devices and factor analysis are methods of treating rather than of collecting data. Historically, there is little or no relation to the development of a method and its position in the classification. The method of systematic observation, which would seem to be an early method, has recently developed in a striking manner. Recently there have appeared a number of books in which consideration is given to methods in child psychology. Symonds (30*a*) and Goodenough and Anderson (11*a*) present a classification and discussion of various methods. In Thomas and Thomas (31*a*) a treatment of various types of approach to the child is presented. Some parts of Rice's (24*a*) presentation of methods in the social sciences are also of interest.

Incidental Observation. If incidental observation is defined as the observation of natural phenomena as they occur, without any attempt to control the conditions under which the observation is made or without any attempt to sample the behavior beyond that sampling which is inherent in any individual's noting what happened, incidental observation becomes the method out of which subsequent methods develop. Every human being makes a number of observations of the behavior of children and of other people and relates those observations in the form of anecdotes, interesting events, and statements of fact. Further, many human beings speculate about their incidental observations and erect upon them a point of view with reference to human behavior. Such observations can hardly be called scientific, whether made by a scientifically trained person or not, since the essence of a scientific approach to a problem is the introduction of a system of selection or control either of the situations put to the child or the reactions which are to be recorded. This does not mean that incidental observations may not be accurate, nor does it mean they are wholly to be distrusted as a source of information. They can be looked upon as devices by means of which we secure the raw material around which later, better

methods of observation and technique will be developed. In general, incidental observations put problems rather than solve them.

Biography. On the borderline between incidental observation and systematic observation is to be found the biographical method, used *in extenso* from Preyer's day on. Attempts are made to record behavior as it occurs and to set down systematically all that occurs. But the systematization is accidental rather than logical, in that the records are confined to a particular child or a few children. Further, because of the limitations of time and energy, there is a selection, partially conscious and partially unconscious, of what is to be recorded. Perhaps the best example of this technique from the standpoint of completeness is the series of studies on newborn infants by Weiss and his associates (22). But here the method is both biographical and experimental. In the best of the modern biographies there are to be found tests, experiments, and other techniques. An excellent example of the use of experiments within a biographical study is to be found in the paper by Valentine (33).

The method is subject to a grave sampling error, due in part to the difficulty of intensively recording behavior on any but a few children, and in part to the fact that the persons who keep such records are usually parents who, being willing and able to keep a diary, are selected individuals and have selected children. Its accuracy increases with the objectivity and capacity of the observer, and its value lies in the recondite view of development which it gives. The biographies as a whole furnish a mine of suggestions for scientific problems, but offer solutions to few.

Systematic Observation. Systematic observation refers to the method in which the observer selects beforehand, from the mass of events occurring in the development of a child, a particular situation or series of situations for observation and develops a technique whereby the responses of the child are recorded systematically following a predetermined plan. Emphasis, however, should be placed upon the fact that the behavior which is recorded is that which occurs naturally. As soon as conditions are artificially controlled or the stage is set in advance, we move over into the experimental and test methods.

In the investigations of Piaget (18-20), Bühler (4), and Thomas (31) examples of the use of natural situations as a basis for systematic observations are to be found. In Goodenough and Anderson (11*a*) a discussion of the methods of systematic observation is found.

Recently two rather promising techniques of systematic observation have appeared. The first, the *technique of situational analysis,* is based on the fact that behavior varies in accordance with changes in the situation in which the behavior occurs. Thus the behavior of children at home may be compared with that at school, free play periods may be compared with set periods, social reactions may be observed when only one companion is present and contrasted with those when three or four companions are present. Many kinds of behavior difficult or impossible to produce under laboratory conditions occur with fair frequency in life. In the large,

psychology has neglected these. It is but a step from the utilization of situations which occur naturally to the setting-up of a relatively simple situation, partially controlled and uniformly presented to a large number of children. In the investigation by McCarthy (15) of the development of language in young children, this technique was utilized. Here again we are on the borderline between observational methods and those involving some measure of control.

The *technique of time sampling,* as developed by Olson (16), Goodenough (10), and other workers, is a technique which introduces no control in the natural situations beyond that of recording events during a constant period of time. Olson recorded the presence or absence of a particular type of behavior, such as putting the thumb in the mouth during a five-minute period. By taking a series of observations on the same day or successive days, it is possible to secure for each child observed a score which shows the frequency of the occurrence of the particular phenomena under observation during the total number of periods in which observation was made. These scores lend themselves readily to statistical treatment, both for determining reliability by correlating scores for odd and even series of observations and for determining relations to other factors. The number of observations necessary in order to secure stable results can be determined. While the use of the method is still in its infancy, nevertheless it is clear that it is more satisfactory for some types of behavior than for others and that the length of the individual period and the number of observations necessary to receive stable results vary with the type of behavior studied. It is quite possible that in actual life an individual is presented with many situations which are quite as constant as those set up in the laboratory and from which predictions of a high degree of accuracy can be made.

Under the method of systematic observation may also be placed the use of conduct samples as a measure of a more generalized trait. Thus in the Hartshorne and May (12*a*) studies children were presented with actual opportunities for deceiving or cheating and conclusions drawn with reference to their honesty. In order to be effective, such situations must be as natural as possible. If the behavior of the child is studied in and for itself, the technique is a variant of systematic observation; if viewed as a test, it is closely related to the tests of complex functions.

Questionnaire. In the questionnaire a method is found which does not fit well into any particular classification, since a variety of techniques which overlap our other classifications may be utilized. At the outset it is necessary to distinguish between two types of questionnaire: (*a*) the questionnaire which seeks to get the opinion of a group with reference to particular situations, modes of behavior, or individuals, characteristics, matters of policy, training, etc., and (*b*) that which seeks to get at the facts which the person filling out the questionnaire is in a position to know on the basis of direct observation, available figures, tests, etc.

In child psychology and elsewhere there is much distrust of the questionnaire. This is in part due to the fact that confusion exists in the minds

of questionnaire makers and those who fill them out with reference to matters of opinion and matters of fact. Thus, if a group of experts were asked to give their opinion as to the value of moving pictures for young children, an expression of opinion would be sought. It would have value only in so far as the particular persons asked to contribute were qualified to express an opinion, but neither the personal opinions nor the group opinion should be considered as the equivalent of scientific data or generalizations.

When, however, the questionnaire deals with facts collected from those in a position to know, it may have much scientific value. Thus a questionnaire which enlists the cooperation of mothers in recording the sleep of their children may be of value scientifically, whereas a collection of opinions about sleep would be of little or no value. Such a questionnaire really sets up conditions which result in systematic observation.

The questionnaire method aims to secure from large numbers of individuals observations which could not be made by a single individual. Its accuracy depends on the skill with which it is made out, that is, the definiteness and specificity, and the practicality of the questions, the capacity of the persons answering, the length of time that has elapsed since the occurrence of the events to be recorded, and the number and selection of persons to whom the blanks are sent and from whom replies are received. It is subject to errors of memory, misunderstanding of terms, and mental sets imposed by the questions. In general, although the results may be suggestive, verification by other methods is necessary.

With the classification, "Questionnaires," Symonds (30*a*), who presents a very complete analysis of the methods available for the study of personality and conduct, places adjustment questionnaires, such as the psychoneurotic inventory in its various forms, measures of introversion-extroversion and of ascendance and submission; attitude questionnaires, such as measures of social attitudes, fair-mindedness tests, and the Thurstone attitude scales; and interest questionnaires, such as the Strong tests for vocational interest, and other measuring devices for the permanence of interests, or of specific types of interests. Some of these devices have been used with children. Although many of these are questionnaire in form, they depart sometimes from the questionnaire in purpose in that they may be employed for the measurement of complex functions.

Psychoanalysis. In recent years psychoanalysis, a therapeutic technique developed for use with adults suffering from neuroses, has been extended to children. Distinction must be made between the use of psychoanalysis for therapeutic purposes, its use as a technique for securing knowledge of the development of the child, and its use as explanatory of the whole course of child and adult development. With its therapeutic use we are not particularly concerned. In psychoanalysis, the analyst, after establishing rapport with another (either child or adult), attempts to secure by a process of free association, dream analysis, interview, or other device for tapping underlying memories, information regarding the origin of mal-

adjustments, complexes, conflicts, etc. By this process of free association and discussion, the analyst seeks to reeducate the person treated so that he may achieve a balance or integration of his instinctual drives and the demands the world makes upon him. The primary purpose is therapeutic rather than scientific. The child is approached from the standpoint of a theory, already accepted by the analyst, as to the organization of mental life.

If a record is kept of the process of interviewing, the material so obtained can be utilized, along with similar records obtained on other individuals, as a source of information about human nature. The books and articles on child analysis, such as, for example, those of Anna Freud (5*b*) and Klein (12*e*), contain records of child analysis, some cases being presented in great detail and others briefly. As one reads them, one is impressed by the fact that the child is always approached from a particular point of view, and that the material obtained from the child and the behavior described is consistent with the point of view. There is little attempt to evaluate except in terms of accepted psychoanalytic theory, no statistical or quantitative material, no statements or records of precisely what the analyst said, or of what the child responded. Moreover, in the published analyses of very young children there is evidence that much of the content found in the analysis is directly or indirectly suggested to the child. Young children are markedly suggestible. In the giving of mental tests to young children special precautions have to be taken to guard against suggestion. An example is found in those tests in which the position of the phrases is varied in order to counteract the child's tendency to repeat final phrases of sentences.

Not only bias on the part of the analyst, but practices in the securing of information which other techniques seek to avoid are operative. As one reads case reports, one wonders how they would be interpreted if complete talking-picture records could be obtained of every word that passes between the child and the analyst. Further, no attempt whatever is made to control the sampling of children subjected to analysis, nor is any precise data collected over a span of years as to the success or failure of the therapeutic treatment made available. One would like to see a control-group technique applied.

From the standpoint of the general theory of child development presented by the psychoanalysts little can be said in the space here available. Perhaps the soundest position to be taken is that of Symonds (30*a*) who feels:

> "Psychoanalysis as a diagnostic technique should be viewed with an attitude of *favorable skepticism*. It cannot be scientifically validated and can be severely criticised when studied in the light of the psychology of testimony, judgment and inference. On the other hand, its keen application of psychological mechanisms, coupled with a dynamic theory of considerable vigor, gives it a somewhat impressive plausibility. Psychoanalysis should be viewed as a promising hy-

pothesis. It offers a unique challenge to the psychologist of scientific bent."

Case History. A third method is sometimes called the case-history method, sometimes the clinical method, sometimes the personality study. Each one of these terms refers to a variant of the method. By the term *case history,* as now used, is meant the collection of such facts about a particular child as can be obtained from official records, his own story, the accounts of relatives, teachers, and others who have had contact with him, and the results of any tests, examinations, or interviews with the child. Case histories of this type, as collected by many agencies dealing with the welfare of children, are of great value in the practical handling of cases. Their value for scientific purposes is, however, somewhat open to question.

By the *clinical method* we refer ordinarily to the description of a pathological or abnormal case. It usually consists of notes on the progress of the particular abnormality and is sometimes supplemented by objective data of various sorts. As the term *personality study* is used in the literature, it refers to two rather distinct modes of approach. One is illustrated by the studies of Woolley (36, 37), who kept a record of the development of a particular child who was somewhat unusual, in a manner similar to that used in the case history, but who also had notes taken over a period of time while the child was developing, as in the biographical method. In general, it may be said that the methods here placed under the case history and including psychoanalysis are *post facto* methods in that the particular case selected for study and notation is so selected because of some outstanding peculiarity, social difficulty, or adjustment problem. In the scientific use of such material a number of difficulties are encountered, the first of which arises from the fact that, working back from any given result, one finds a bewildering complex of factors from which selection as to relative importance is made almost entirely on the basis of one's background and experience. Sincere workers, going over the same history, come out with different analyses, no one of which can usually be completely verified. We are all familiar with the welter of causes to which crime is ascribed. But the underlying logical error goes deeper and is primarily a matter of sampling.

If we consider the relation of two discrete variables, such as, say, age of father at birth of son and greatness of son, there are four possible combinations—old fathers and great sons, young fathers and great sons, old fathers and mediocre sons, and young fathers and mediocre sons. A student, noting that great men sometimes had old fathers, might draw the conclusion that greatness was related to the age of the father at the time of the son's birth. By going through biographical dictionaries, he might select a large number of historical examples and build up an impressive mass of evidence, which, however imposing, would be of little or no scientific value. To know the true relation we must have more than the frequency with which the two factors occur together; we must also

have the frequencies which show how often either factor is present and the other absent. In the same way, one can demonstrate that red hair is related to executive ability and that mental abnormality is related to early sex experiences. Mere concomitance, without further analysis, does not justify one in assuming the existence of a relation where complex factors are involved.

The value of the clinical or case-study method lies not so much in its solution of scientific problems as in its putting of problems to be solved by more adequate scientific methods. The method is subject to errors of memory, of retrospective falsification, mental sets, and suggestion. These are well illustrated in the accounts of the genesis of mental life written from an adult background, without actual observation of children. Its accuracy increases with the number of similar observations and conclusions reported by different observers, providing no common factor producing bias or set has been at work.

Direct Measurement and Simple Tests. Many measurements and tests are made in which the investigator is primarily interested in the measures themselves and not in their value as indicators of more complex functions. The best examples are furnished by measurement of height and weight in which a direct measurement is made with almost universal agreement as to what height and weight mean. In the psychological field, direct measurements of memory for nonsense syllables, of tapping, of the speed of writing, of reaction-time, and of other acts may be made. In direct measurement, questions of validity do not ordinarily arise, largely because the investigator is dealing with those characteristics of the individual about which there is universal agreement and which, by virtue of that agreement, can be clearly and distinctly separated from other aspects of the functioning individual. When an individual's height is found to be 5 feet 1 inch or his reaction-time to a visual stimulus to be 190 sigma, there can be little disagreement as to what is meant.

In direct measurement the question of reliability seldom arises. Because of the lack of ambiguity and the clear separation of the function studied from the remainder of the functions of the individual, adequate measuring devices can be set up. When we come to the more complex functions of the organism, however, one first has to separate out the particular function to be measured from the mass of mental functions in which it is placed, and then to demonstrate that the measuring instruments devised give consistent results.

Many of the tests of children fall under the heading of direct measurement. For instance, a spelling or arithmetic test, as ordinarily administered and used for the purpose of determining the level of performance of the children on a particular occasion, is a direct measurement. In the intelligence test, on the other hand, we have an indirect measurement. It is not obvious that any of the particular items measure intelligence, nor is it obvious that the whole measures intelligence. By a process of validation we demonstrate that that which is measured is a complex function which

has a certain internal consistency and which, by virtue of that internal consistency, can be separated out from mental life and behavior as a whole.

The limitations of the use of direct measurement and simple tests can hardly be discussed in the space here available, largely because each individual device has to be discussed in and for itself. Such a variety of devices are used that no general statements can be given concerning all. Whipple (35*a*) summarizes the results of many such measurements on children.

Because of the widespread use of direct measurements and simple tests in the normative approach to the child, it may be well to discuss for a moment two terms which in some texts are referred to as methods. Reference is made to the *cross-section* and *longitudinal methods* or approaches.

Briefly, the distinction between them may be made in terms of whether norms are secured by the study of different groups of subjects at different stages of development (cross-section) or by the study of one and the same group at different stages (longitudinal). In the strict sense, every longitudinal study is ultimately a cross-section study, since the longitudinal picture is built up of successive cross-sections. Ideally, the cross-section approach involves the use of a large number of cases, sampled from the general population in the same way, at successive periods. The longitudinal approach, because of limitations of money, time, energy, and space, has usually been confined to a small number of cases, though increasingly large numbers are being used. Where the groups are restricted in number, the sampling errors inherent in the original selection run through all subsequent observations, complicated by the fact that differential elimination is almost certain to occur. Actually, however, the two approaches may be used to check one another. Increments of height obtained from a large number of different cases at different age levels can be checked by increments of height obtained on a limited number of the same cases carried through successive age levels.

Tests of Complex Functions. The term *test* as here used refers to devices for measuring complex functions in which the relationship of the device to the function measured is not obvious so that a process of validation becomes necessary. Usually an attempt is made to cross-section behavior or aspects of behavior at various levels by a series of items, no one of which can be said specifically to measure the function studied, but which, taken as a whole, can be shown to measure the function. If a scientific approach is to be made, it is necessary to break up the complexity of mental life and behavior and to analyze its major aspects. The practical problem faced in making such an attempt is that of getting a foothold or a lever by means of which an aspect can be separated out for study. In popular language there are many terms descriptive of the components of mental life which seem to have some meaning. For the scientist, however, the popular meaning does not suffice. His task is to make it precise and workable.

The problem is best illustrated by instances from the field of the measurement of intelligence. Binet used teachers' ratings as one of the criteria against which he standardized his measurements, age progression as another, and school progress as a third. Later workers developed another criterion, that of internal consistency or coherence, the relationship of a component part or item to the whole, on the theory that the results obtained by a series of measures were nearer the complex function than any particular individual measure. Through the application of these criteria it was possible to select a considerable number of individual items or tasks which superficially do not seem to bear any relationship to one another, and to put them into a scale which gives consistent and interpretable results, and which can truly be said to measure a function, even though it is impossible to define the function measured.

Validation is not the only technical problem involved. A test that today puts an individual at the top of a group and tomorrow at the bottom would be as bad as a ruler which today recorded the height of a table as three feet and tomorrow recorded it as one foot. Test scores must show high correlations with themselves if repeated at short intervals of time, if they are to be of much value.

The problem of reliability is of great importance in those studies where stress is laid upon the differences between individuals. Although detailed discussion of the techniques involved lies outside the realm of this paper, it is necessary to emphasize the point. No student who sets out to prepare a measuring device for a complex function can afford to neglect the problem of reliability. A very complete discussion of the technique of standardizing and validating measures of complex functions is presented by Hull (12*c*).

It is quite possible that the technique of measuring emotion by the expressive method or physiological resultant should be placed under this heading, although it is conventionally not so regarded. The emotion is, however, a complex function. In the study of emotions questions similar to those of validity and reliability arise, even though they cannot be so precisely formulated as in the case of intellectual functions. Symonds (30*a*) presents a summary of these methods.

The value of the measurement or test method lies in the tool which is fashioned in accordance with logical and statistical criteria. With it numerous problems can be solved, despite the fact that sometimes it is felt that in building a good tool we have so structuralized our methods as to miss the more appealing problems of development. Further, the construction of such a tool increases the possibility of the application of other methods to a wide range of problems previously inaccessible.

Ratings. Within recent years there has been marked development in the rating methods. In the present state of our knowledge, and possibly permanently, there are many complex phases of mental life and behavior that do not lend themselves readily to direct measurement, and which can be attacked only in a limited way by the use of the test method. For the

analysis of these, ratings or ranking methods are in common use. The techniques involved are of two general types, of which the first is the direct or indirect comparison of stimuli, situations, individuals, or responses and the assignment of the separate items, individuals, etc., to a relative position or rank-order position with reference to each other. Thus teachers may rate a group of children with respect to honesty by placing the most honest (according to definition) child in the first place in the rankings, the least honest in the last place, and the others at appropriate places in between. The second technique involves the categorization of a number of aspects of the life or behavior of the individual, and the placing of the child in his approximate position within each category by marking off his distance either graphically or numerically from the bottom or top of the possession of the particular characterization. Thus an item in such a rating scale might contain five descriptions of honesty, varying from more to less, and the rater be required to locate the particular child somewhere within the five descriptions. The variants in the general form of rating scales both in the devices used within items and in the method of integrating the items into a single score are many. Self-rating scales are also in use. The technique can also be applied to children's products such as drawings, writing, and the like.

In the use of the rating scales a number of important questions arise. Of these the first group arises out of the fact that, in the construction of such a scale, assumptions are made with reference to the mental trait or aspect under study, both with respect to its nature and its linearity. Often the results obtained are the consequences of these assumptions. Starting with different assumptions, different results may be obtained. Secondly, there are marked differences in the raters' knowledge of individual children and of their performances with respect to the different items on which rating is sought. Thus a rater may know one child well and have only a bare acquaintance with another; he may have seen one child many times in a situation which called for the particular behavior in question, and another child, equally well known, only a few times in such a situation. Data collected by the rating-scale method lend themselves so readily to quantification that frequently the mere manipulation of figures results, without basic inquiry into the nature of the phenomena which are rated.

Experimental Method. With the experiment, we move on to the classical method of science, the method which in many ways can be looked upon as the ultimate goal, from the standpoint of method, of any system of investigation. The essence of the experiment is to be found in the fact that conditions are controlled artificially in such a way that stimuli can be presented and a reaction obtained without the necessity of awaiting the occurrence of events in the natural environment. Events are taken out of their setting and placed before the child. In a relatively short period of time a number and type of observations that could hardly be collected in any other way are obtained.

The relationship between incidental observation and the more complex

methods of studying behavior, such as experiment, becomes clear as sources of experiments are considered. Originally, observations of some sort are made with respect to certain phenomena. On the basis of these observations a generalization or hypothesis is made. A special technique is then set up by means of which the hypothesis is tested. The experiment is a device which will either positively or negatively solve the problem put by the hypothesis. The value of the hypothesis, which is really a statement of a scientific problem, is directly dependent upon the possibility of its being experimentally tested. As science advances, we move from observations as the source of hypotheses to earlier experiments. Frequently students of behavior make the assumption that experiments can be carried on without preliminary conceptualization on a basis of observation or earlier experiments. No assumption could be farther from the fact. The value of an experiment bears a fairly direct relationship to the amount of time which is spent in its preliminary formulation.

Moreover, the ability to carry on research is largely an ability to formulate a problem, rather than the ability to carry on the routine of investigation subsequent to formulation. In the experiment more is involved than merely presenting the child with situations. Ideally, an experiment involves the control of all the factors in the situation and in the reactors, except the particular one which is under investigation. This control or holding constant of all other factors results in the investigator's being able clearly to connect a response or experience with the particular stimuli or situation which has been set up and enables him to isolate the significant factors. Theoretically, in setting up an experiment, the investigator knows the weight and effect of the factors he wishes to control. Otherwise he cannot set up adequate controls. When the experimental set-up is completed, the results of the experiment are crucial in answering the particular question. We seek to determine the effect of a given amount of practice on the acquisition of a motor skill and assume that practice extends over some time. Obviously, the time over which the practice extends, if a growing organism is studied, is one in which growth or maturation takes place, in addition to practice. If the effects of growth or matura[illegible] were known in advance so that whatever effect growth or maturation had could be subtracted from the result obtained at the end of an interval of time in which the organism had practiced, the problem would be well on the way to solution. In many experiments in the physical sciences the effects of particular factors are so well known in advance that the ultimate set-up, no matter how long the process involved in reaching it, seems remarkably simple and clean-cut.

In child psychology, on the other hand, the ideal of controlling all the factors save the particular one under study, and of permitting that factor to vary, is achieved but rarely, since it is almost impossible to know in advance the effects of various factors. In the instance cited, if human beings could be held in *status quo* for a period of time, if their motivation and the amount of previous incidental practice could be controlled, the effect

of practice upon the particular act we were seeking to study could be obtained. The direct experiment would be crucial and would answer once and for all the question originally proposed. Since we have great difficulty in setting up an ideal experiment in which all the factors except one are controlled, we proceed practically by controlling all the factors of which we have knowledge. Other devices such as control groups measured in the same way as the experimental group are developed for eliminating other factors.

One further characteristic of the experiment should be mentioned, namely, the possibility of repetition and verification by other workers who reproduce its conditions. Out of repetition and verification, correct generalization is ultimately established. Unfortunately, psychological experiments lend themselves much less readily to reproduction than do experiments in other scientific fields. This is partly due to the length of time involved even in simple psychological experiments and to the fact that so few of our experiments are crucial in the sense in which those in the natural sciences are.

Since the techniques of experiment vary with the fields and problems which are attacked and involve many questions as to the use of specific measuring devices, instruments, etc., little can be said about their limitations. But it may be said that the value of an experiment increases with the specificity of the problem proposed.

Experiment Involving Random Control Groups. Many problems are attacked by the child psychologist in which it is impossible directly to control all the factors through an experimental set-up. In a developing organism various phenomena take place as a result of maturation and incidental stimulation rather than as a result of the introduction of an experimental condition. To meet this difficulty the technique of the control group has been used. The procedure involves the division of a group of children, either on the basis of preliminary measurements, tests, or known data, into two groups of approximately equal size and constitution. Thus the fourth grade of a school in a district of medium economic status might be used as an experimental group, while another fourth grade in a similar district might be used for control. One group is then subjected to the experimental condition for a definite period, while nothing is done with the other group. At the end of the period, both groups are retested. The change in the control group is then subtracted from the change in the experimental group, and the remainder considered the effect of the experimentally introduced factor. Various means other than simple subtraction are also used in analyzing data furnished by such studies.

Frequently, additional measurements are made of both groups after the lapse of a period of time in which no new condition has been introduced. In this way a double check is obtained, since a comparison of the experimental group with the control group is made at the end of the experimental period and a further comparison of both groups is made after a period of time in which the experimental condition is absent.

In the early use of control groups, it was the practice to use a relatively small control group and a large experimental group. In recent years control groups as large in size as the experimental groups and selected in an identical manner have been used. In general, where random groups are used for control, large numbers are necessary for both the experimental and the control groups. It is also likely that the more complex the phenomena studied the larger the groups must be.

Experiment Involving Paired Control Groups. Since the difficulty of securing random samples of sufficient size under ordinary practical conditions is great, another technique for setting up control groups is frequently used. This consists in pairing the members of a group, individual by individual, with respect to a number of factors, putting one member of each pair in the control group and the other member in the experimental group. Thus, for instance, in a study undertaken by Goodenough (11) on the influence of the nursery school upon changes in IQ, children were paired with respect to sex, age, IQ, education of father, education of mother, socio-economic status of the father, and the nativity of parents. In pairing, it was necessary to have a group of over three hundred children from which to draw in order to secure "matches" which met the requirements imposed by the experimental group of twenty-eight children used in the study. An interesting example of the use of the pairing technique is furnished by the Gates and Taylor (6, 7) studies. Where pairing is resorted to in order to secure a control group, the experimental study can be carried out on a smaller number of cases than where random groups are used. But a large population must be available in order to select the pairs. In general, the greater the number of variables used as a basis for pairing, the greater the population from which the controls must be selected. Relatively slight differences in results are of greater significance where pairing is used than where random groups are used.

A modification of the method of control through pairing is furnished through the fact that nature occasionally does an excellent job of pairing by producing identical twins. Gesell (8) has developed the *method of co-twin control,* which consists in making a series of measurements and observations on both members of a pair of identical twins, then subjecting one member of the pair to an experimental situation (such as practice in stair-climbing), while the other remains in a natural environment or is prevented from exercising the particular activities in which the other is being given practice. At the end of a definite period, measurements are made on both the practiced twin and the control twin, and conclusions drawn. Although the method so far has been applied only to single pairs, there is nothing intrinsic, beyond the relative inaccessibility of identical twins in large numbers, that prevents its being used on a larger scale.

Control by Statistical Devices. In the experiment an attempt is made to control all the factors except the particular one undergoing analysis. The necessity for experimenting arises from the fact that, because of the number of variables involved, some procedure must be adopted to hold

certain variables constant. By the use of partial correlation, a statistical rather than experimental technique, a somewhat similar result can be secured. The technique is chiefly utilized in the analysis of relations where an experimental set-up is impossible because of the nature of the material to be gathered, or as a substitute for experiment. An illustration will make the point clear. Suppose that the relations between three variables—intelligence test scores, amount of time spent in studying, and scholastic success—are being studied. After a number of observations or measurements of children with respect to these three variables are secured we can proceed by the use of partial correlation to hold constant the time spent in study and determine the relationships between intelligence and scholastic success. Or we can select two groups of children who differ in intelligence, pair them with respect to time spent in study, and then measure the relationship between intelligence and scholastic success. Or, using the experimental method, we may take a group of children who vary with respect to intelligence and place them under conditions in which the amount of time spent in studying is controlled by making it equal for each child, and study the relation between intelligence and scholastic success. Although we may recognize the fact that such factors as motivation or the energy with which study is carried on are not controlled by controlling the time spent in study, nevertheless a clearer picture of the relationship between intelligence and scholastic success is obtained with the time of study artificially held constant. Here are three techniques for attacking the same problem, ranging from one involving complex statistical treatment to one in which the statistical treatment necessary is relatively simple, since, by deliberate control of one factor, much of the subsequent need for complex analysis is eliminated. This brings us to a rather important point with reference to method: In general, control of conditions in advance is to be preferred to a mass of measurements accumulated on a large body of cases without such control and then subjected to involved treatment. Although statistics furnishes a most valuable tool for the handling of data, it never becomes a very effective substitute for more precise methods of collecting data. As methods of collecting data improve and as accurate knowledge of the weight and significance of factors increases, the more will our experiments possess the characteristic of cruciality so typical of experiments in other sciences.

Factor Analysis. Given a series of observations on various phases of mental functioning obtained under uniform conditions on a number of subjects, it is possible to subject the resulting data to statistical analysis and obtain information as to the presence or absence of the common factors that are operative. It has been pointed out that in the development of tests of complex functions an attempt is made to secure a lever or foothold by means of which one aspect of functioning can be selected out for study, and a scale developed for measuring it. In factor analysis, this procedure is reversed, a large number of measurements are secured, subjected to statistical treatment by methods such as tetrad differences, and the presence

of common factors and the extent of their discreteness determined. Spearman (*27a*) has been chiefly responsible for this type of analysis. Kelley (*12d*) presents an application of the method to children at various levels of development.

Conclusion

Within the field of child psychology problems are being attacked in a variety of ways by workers who are increasingly concerned with the technique and methodology of investigation rather than with immediate results. The science seems to have passed through that first enthusiastic rush toward children as subjects of investigation—that rush in which results at any cost were sought—and has moved on to that more mature attitude which is concerned with a critical examination of results in terms of method and with deliberate attempts to devise new methods and techniques for attacking the very complex phenomena before it. It would be unfortunate if too much preoccupation with a particular method or a preconception of what child psychology *should be* rather than *is* were to cut off a manifold approach. From today's studies, however inadequate they may be, come the highly developed techniques of tomorrow. Science crawls before it walks, and walks before it runs. Methods and techniques do not fall into classifications of right or wrong, of all or nothing. They are the tools which man forges as he goes along. Scientific sin consists not so much in the use of a particular method as in the failure to use a more adequate method for the problem in hand when such a method is available.

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PART II

DEVELOPMENT OF CHILD BEHAVIOR BEFORE BIRTH

CHAPTER 2

ORIGIN AND PRENATAL GROWTH OF BEHAVIOR

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Yes,—the history of a man for the nine months preceding his birth, would, probably, be far more interesting, and contain events of greater moment, than all the three score and ten years that follow it.
—S. T. COLERIDGE (84, p. 301)

I. THE GENETIC METHOD IN PSYCHOLOGY WITH ESPECIAL REFERENCE TO PRENATAL LIFE

In a complete consideration of child or genetic psychology the question may appropriately be asked, "How does the mind originate in the individual and how does it grow before birth?" Or, possibly more exactly, "What is the origin and embryology of those characteristics of the living individual that are ordinarily considered as significant for psychology?"

In this chapter an effort will be made to deal with these questions, in so far as the present status of scientific investigation makes it possible to answer them. In answering them, certain facts will be presented which have a direct bearing upon an understanding of human mental life at any age, when mental life is considered as made up of natural processes. A knowledge of prenatal life will, the present writer believes, throw light upon many traditional psychological problems such as the relative importance of heredity and environment in the determination of human mental life, the nature of instinct, the nature of the empiricistic and nativistic theories of perception, the question of whether development is continuous or saltatory, the problem of the mechanism by which behavior becomes specific, and the problem of the mechanism by which behavior becomes integrated, the fundamental nature of learning, and many others.

In understanding any behaviorally or introspectively known psychological characteristic, it is important to keep separate the problem of the adequate and, whenever possible, quantitative *description* of the characteristic from the problem of the nature of the genetic development or growth of the characteristic under consideration. Thus, a description of the child's functional use of language at five years of age is quite a different thing from the description of the essential stages through which the child has passed in order that the use of language may be as it is at the age being studied. In this chapter, therefore, an attempt will be made to avoid the *error of potentiality,* long ago considered by Lange (195, pp. 198-200), that is, the assertion that anything is genetically potential in something

else, save in so far as such a statement can be made as a description of facts of observation.

The scientific genetic method, indeed, seems to consist not in dealing with potentialities but in an effort to describe, by means of controlled observation and, whenever possible, by means of experimentation, a series of temporally separate stages in development. The question to be answered becomes not what adult trait is hidden in this or that embryonic condition, but what is the nature of the developmental stages antecedent to the particular adult characteristic which is under consideration. In the study of prenatal development of behavior, this distinction becomes particularly important. For example, it makes possible the statement of the facts of observation without the assumption of any special theory of inheritance or recapitulation. So-called hereditary determinants, or so-called environmental determinants, or some special relationship between these two sets of determinants may ultimately be shown to be the essential basis of a particular development. Whatever the essential determinants may eventually turn out to be, however, the description of the course of development, in so far as it is scientifically adequate, must be valid. Like the wax reconstruction method of the histologist, it makes possible a useful "long-section" view based on adequate cross-sections. Or, possibly in a better analogy, the measurement of successive stages makes possible the construction of a curve, connecting all measured points, and thus a graphic representation of change in a system of coordinates.

If a genetic study of psychological phenomena aims thus to describe a satisfactorily complete series of developmental stages, the question at once arises as to which stage shall be taken as a starting-point of development. Compayré may be taken as giving the typical answer to this question when he says that this study shall begin at birth (85, p. 44). From the time of the Greeks, however, it has become more and more obvious to certain writers that prenatal behavior is significant in an understanding of the course of postnatal development. This being the case, we must ask again, in Gesell's terms, "What is the ontogenetic zero?" Gesell himself answers that the zero point may for practical purposes be set at the time of fertilization (125, p. 631; 124, pp. 303-306). For a number of reasons, this conclusion seems justified. It must not be taken as absolute, however, for it should not be forgotten that the succession of generations is endless. *Omne vivum e vivo*. At any point in development, therefore, processes may be pointed to which are essential antecedents in some respect to any stage then under consideration. Even at fertilization it is certain, for example, that the biological processes which eventually lead to the development of a new individual, and therefore to those activities which are called mental, may be found in the early development of the parents who produced the germ-cells.

On the other hand, there is some reason to say that the beginning of behavioral psychology shall be placed at the point where neuromuscular activity begins which involves the total organism. It is at this point that

"behavior," in the strict sense of the term, is ordinarily thought of as *emerging*. In passing, it may be noted that this too-often misused word "emergence" need not be employed in a mystical manner. It seems that there is nothing essentially non-causal in correctly understood emergence. Indeed, where antecedent events can be shown always to precede certain subsequent events, one may see typical emergence, but the same process may at the same time illustrate most clearly an invariable genetic relationship. For an evaluation of the valid and invalid use of the term "emergence," see Lovejoy (216).

Practically, however, the nature of emergence raises some real problems. Suppose that at six o'clock stimulation of the receptors of an organism leads to no response, but that at one minute after six the first of such responses ever made by that organism occurs. Is this the onset, *de novo*, of receptor-neuro-muscular response, and therefore, according to one view at least, of the adaptation of the total organism to its environment and thus of mind?

A glance at the stages of development which have gone before this response may answer the question. The possibility of this response is dependent upon elaborate processes which have occurred before in the organism under consideration. These processes involved the development of the germ-cells in the parents, the maturation of the germ-cells, the reduction divisions, the fertilization, the cell division, the cell differentiation, the cell migration, the organ formations which have led up to this response. Without these antecedent processes, this first external response does not occur. Moreover, as will be shown in the conclusion of this paper, these processes are not to be considered as the mere unfolding of preformed organs considered in independence of an environment, but they are rather at each stage describable in a dynamic relationship to the energies surrounding them. That is, each developing cell has functional energy relationships with the cells and energies that surround it, each organ with the energies and organs that surround it, and so on.

Thus, so far as the zero point of development is concerned, it must be remembered that before fertilization events are occurring that are significant in building the new organism, and hence present a series of possible zero points. After fertilization the first external movement is also a possible zero point, but certainly not one that is absolutely placed, for there is evidence that development occurs in a dynamic continuum of relationships between organism and environment. Practically, then, for all the difficulty of its determination, the time of fertilization is probably best taken as the zero point of these processes which are to produce the new individual. At a later point in this paper we shall see that there is difficulty in the determination of this point in the human individual.

If the development of behavior in all forms is to be considered, however, it must not be forgotten that there are various types of reproduction and various types of development after reproduction. Thus, in many types the fertilized egg develops within a protective covering or even within the

maternal body. In such cases development of all the fundamental organ systems, save in certain instances, may be complete before hatching or birth. This is a characteristic condition in many vertebrates, in some worms, and in some arthropods. In certain forms, such as the coelenterates, insects, and the vertebrate amphibians, there are varying stages of development after the new organism emerges from the egg. The first stages of development of the organism are characterized as *germinal,* the next as *embryonic,* and the later stages of the higher forms as *fetal.* The term *"larval"* is used to describe independent-living, but organically immature, organisms. The types of larval development have been divided into two classes, which may be respectively called direct and indirect. In the first of these forms the development is in a sense linear. Each developmental stage produces an organism which is more like the adult than was the organism in the preceding stage. In the case of indirect development, however, larval organs are produced which may later be destroyed before maturity is reached. In certain insects this indirect developmental process is very complex. The term *"metamorphosis"* is applied to development of this sort. The terms *"larva"* and *"pupa"* are applied to describe various stages of indirect development. So far as the author is aware, almost nothing is known of the influence of the behavior during larval stages on the behavior of the adult form. For example, it may be asked what influence the activity of the larva has upon the behavior of the fully developed *imago.* It is possibly not without significance, however, that the insects which undergo this complex development are types to which those wishing to postulate innate instincts, such as Bergson (18, pp. 172-176) and McDougall (230, pp. 69-71), point with great assurance.

In the case of strictly embryonic and fetal development there is also significant diversity in the degree of maturity reached before the new organism begins an independent existence. In so-called oviparous species, such as most fish and certain amphibians, eggs are laid as single cells and are fertilized after they have left the mother's body. In strictly viviparous animals, such as certain fish and most mammals, on the other hand, all of the early developmental stages are passed within the mother's body. Between these two extremes are the so-called ovoviviparous organisms in which fertilization at least occurs before the egg is laid. The birds are typical examples of this type. It is difficult to make any sharp line of demarcation in so-called evolutionary development in regard to the place of development of the new organism. The common dogfish bears its young inside its body until they are well enough developed for independent existence, but among the mammals the monotremes lay eggs. There are, moreover, certain forms in which favorable or unfavorable external conditions apparently determine the fact of hatching of eggs inside or outside of the mother's body (144, p. 151).

It must also be noted that embryos develop to a much greater degree of complexity in certain forms than in others before birth or hatching. Thus, among mammals, the young of the opossum are born in a relatively imma-

ture condition (140, p. 252), in comparison with the well-developed condition of the guinea pig at birth (13, pp. 258-265). This fact will have to be kept in mind at all times during the reading of the following pages, for it is peculiarly significant in any correct understanding of the importance of birth in the process of ontogeny.

With this brief introduction, it is now possible to consider something of the ontogenetic development in various typical forms selected because they are significant for an understanding of human development.

Even in the lower vertebrates we shall see that fetal development is of especial significance in a number of ways to the student of the development of behavior in man. As a glance at Figure 1 will show, there are stages in the morphological development of the fish, amphibian, reptile, bird, lower mammal, and man which are so similar as to make the study of one form important for a knowledge of all other forms. By analogy, and with definite reservations, the same is true for behavior. In spite of similarities, however, great care must be taken not to attempt to see homologies of behavior until by direct observation such homologies can be shown to exist. The fish, the amphibian, the reptile, and the infrahuman mammal, in certain cases at any rate, develop in such a manner that a knowledge of the changes which they undergo is of real significance for one who wishes to understand early human growth. Certain of these forms, moreover, are peculiarly available for experimental study. In many instances in these forms the nourishment during the entire fetal period is provided by the yolk of the egg from which the organism developed. Thus, particularly in the fish and the amphibians, it is possible to study the early growth of the individual through the transparent protective coverings of the egg, or independently in water, from the very first stages of growth until the organism has developed behavior which is characteristic of its adult form. For example, the movements of the adult amphibian show something of what Swenson (313) has called the seven fundamental acts of behavior in mammals: namely, progression, respiration, ingestion, expression, excretion, phonation, and reproduction. We shall see later in this paper that a full knowledge of the development of behavior in the amphibian makes it necessary to consider a new interpretation of the development of behavior even in the human fetus. Coghill and others have recently expressly developed this view (74, pp. 1004-1009; 346, pp. 180-184).

II. The Development of Behavior in the Lower Vertebrates

The best history available of the development of the scientific study of vertebrate embryos is given by the scientist who did so much for the study of behavior that he may be considered as the founder of the experimental study of early behavioral stages, Wilhelm Preyer, late Professor of Physiology at Jena, in his *Specielle Physiologie des Embryo: Untersuchungen über die Lebenserscheinungen vor der Geburt* of 1885.

Preyer reviews the many observations that have been made on the early movements of fish embryos (277, pp. 396-402). Such studies involved the

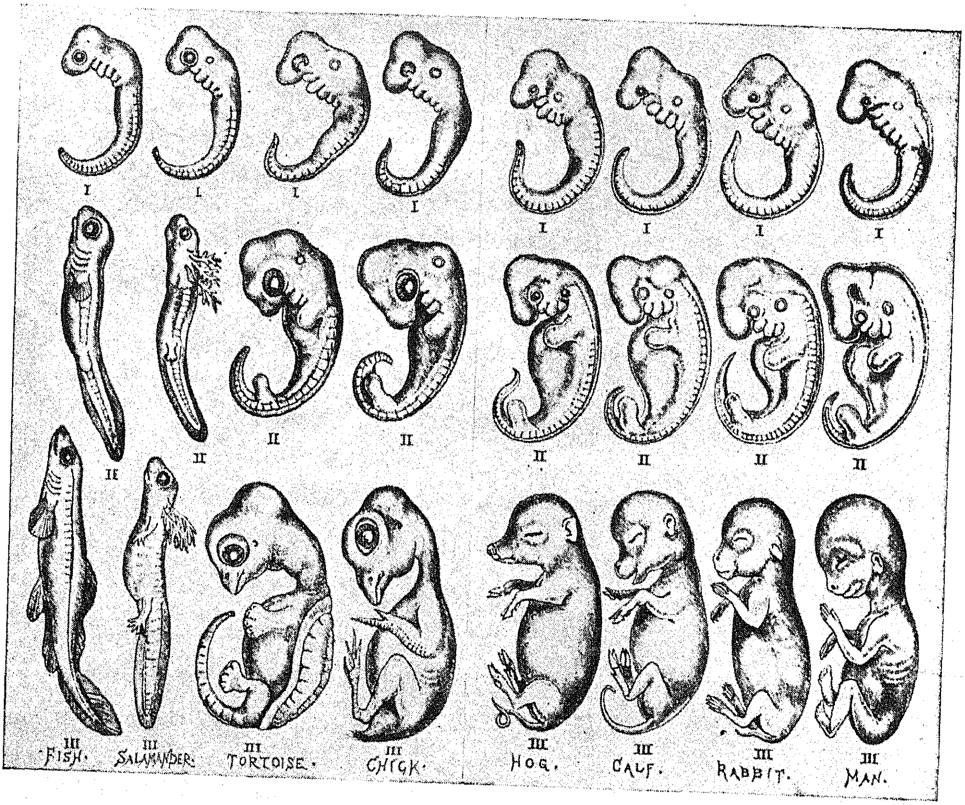


FIGURE 1

A Series of Drawings Constructed to Emphasize Similarities in Structure in Various Embryos at Three Comparable and Progressive Stages of Development (Marked I, II, and III)

(From G. J. Romanes' (285) *Darwin, and after Darwin: Vol. I. The Darwinian Theory*, pp. 152-153. Chicago: Open Court, 1896.)

consideration of fish embryos developed after definitely dated fertilization. Embryos of this sort were early observed to make slow rotary movements thought possibly not to be truly muscular. Fillipi is quoted by Preyer as finding in *Alosa finta* such movements a few days after fertilization. Other early observations on the first responses of the fish embryo were made by Schonberg. Preyer himself has studied the development of behavior in fish in some detail. In a species of trout he found movement of the trunk on a definite number of days after fertilization. On the average, on the day following the first trunk movement the first head movements were noted, and then in a few days energetic movements of the whole body were observed. On liberating the organisms from the egg, it was found that tactual stimulation of the body surface was followed by a generalized movement of the whole body. At this time, however, Preyer points out that possibly the movements of the fish embryo cannot be considered as involving fully developed reflexes (277, p. 397). The movements instead consist rather in the total organism's drawing-together of the head and the tail in what may be characterized as a relatively undifferentiated and generalized response, no matter where the organism is stimulated. As time progressed, however, the strength of the movements increased and the movements also improved in regularity and in their specific relation to the point stimulated. Preyer gives quantitative tables of the increase in rapidity of the movements of the heart and the gill apparatus as development progresses (277, pp. 398-399).

More recently Paton (262, 263) has studied the mechanical aspects of the development of behavior in selachian embryos. He notes that movement is possible in a fish no longer than 9 or 10 millimeters. White (338) has described the development of behavior in brook-trout embryos from the time of hatching until the yolk-sac is absorbed. "The hatching is initiated by movements starting at the head and later extending through the whole length of the body" (338, p. 46). After hatching, the swimming reaction is gradually perfected. Touch and mechanical jars are effective stimuli immediately after hatching; the head is the least sensitive region to touch stimuli. Rheotropism, negative phototaxis, and photokinetic responses are also present at hatching. Excess of carbon dioxide in the water in which fish are studied is activating up to a point and then it becomes depressing on bodily functions. Before the nourishment-supplying yolk-sac is absorbed (up to about two months) the reactions of the fish seem to be away from stimulation; after this they quite suddenly become exploratory and aggressive (338, p. 59). This relationship between "drive" and exteroceptive response can apparently be made out in all organisms up to and including the human individual.

Nicholas (252) has applied experimental methods to the development of Fundulus embryos, and other students have worked on the development of the fish, but from the general standpoint of the development of behavior the work of Tracy (322), published in 1926, is most important. This investigator elaborately studied fish embryos, especially those of the toad-

fish. He records the growth of activity in this form from its first movements to the free-swimming stage. The first activity of the embryo is what may be termed in Parker's sense the "independent effector" action of the heart (259, pp. 53-63). The first true behavioral movement of the organism is the bending of the trunk in the anterior region; sometimes this movement occurs to one side and sometimes to the other. It is thought that the afferent proprioceptor system is absent at first. Soon a "spontaneous flutter movement" develops. This movement is probably significant in freeing the organism from the egg.

In general, the toadfish larvae, after hatching, lie at the bottom of the containing vessel and then suddenly move. On the basis of many lines of evidence, Tracy comes to the conclusion that this "spontaneous" behavior is related to blood changes working on the central nervous system. He holds that "spontaneous" movements are stimulated by metabolites and oxygen deficiency (322, p. 345). After the onset of such responses, however, the organism soon becomes exteroceptively sensitive. The first sensitive cutaneous area is the mucous membrane of the mouth. In general, the spread of sensitivity is from this point toward the tail region, or possibly to the region that has been most active, the cephalocaudal progression being far from regular, as shown in Figure 2. Soon other senses become effective in the developing fish, including receptors for vibration, acid, light, and body movement (proprioceptors). As reactions to this sort of stimulation, jaw movement, trunk movements, and rotational and post-rotational nystagmus of the eyes appear.

Tracy asserts on the basis of these studies that if external conditions could be kept constant the activity of the organism would be determined by its own metabolic processes and would be "rhythmic, like muscle in a balanced salt solution" (322, p. 345). At a later point we shall note that Brown (39) has held that early mammalian reflexes may be essentially of this nature. Tracy then concludes that "from the beginning and more or less continuously during its whole existence, the animal is driven through its environment as a result of stimuli which arise periodically in connection with its own metabolic processes" (322, p. 248). The exact nature of this behavior is to be experienced only in terms of an understanding of neural development and the "interference" in these activities brought about by the stimulation of the special exteroceptors by external energies.

A number of studies have been made on the development of behavior in amphibian embryos. Swammerdam, in his *Biblia Naturae,* written before 1685, makes observations in regard to the movement of frog embryos five days after fertilization. He further discusses the nature of the behavior of this organism after activity has begun (308; 309; 277, p. 392). In connection with this observation of Swammerdam's it may be of interest in passing to note that he also studied the development of behavior in snails and other invertebrate organisms. In this latter study interesting observations were also made by one of the first of the modern biologists, Anthony Leeuwenhoek, and published in 1697 (209, p. 792). Among other early

students of the behavior of invertebrates may be mentioned Home (154), Stiebel (304), and Grant (133). Bischoff in 1842 confirmed the movements previously observed by Swammerdam in amphibians. He also noted that the rate of activity of the movements was a function of the temperature of water. Preyer has reviewed this work and that of Perschir and Cramer on the amphibian embryo (277, p. 392). Preyer himself observed the early movements of the frog and salamander embryos. He notes that stimulating the embryo led first to a slight twitch of the head. Temporally, following this, he notes that sometimes the body was bent so as to bring the head and tail near together. This C- or reverse-C-activity might happen once or twice to the left and then once or twice to the right, and so on. He notes especially that, as these C- and reverse-C-movements increase in speed, out of them develops an S- or a reverse-S-form of movement. This may be made more clear by a reference to Preyer's original drawing, reproduced as Figure 3. Preyer further points out that this newly developed S-movement may be thought of as instrumental in freeing the organism from the egg and that it must be considered as related to the activity of swimming (277, pp. 393-394). In the course of observations upon the gradual development of this C-reaction through the S-reaction to swimming, he points out that an increase in the functional capacity of the nervous system must be inferred.

A number of other students have worked on the relationship between temperature and special embryonic movements in the larval amphibian (277, p. 395), and many others have used this convenient laboratory type in work in experimental embryology, much of which has direct bearing on the problems of this paper. [See Detwiler and the bibliography given by him (104-108).]

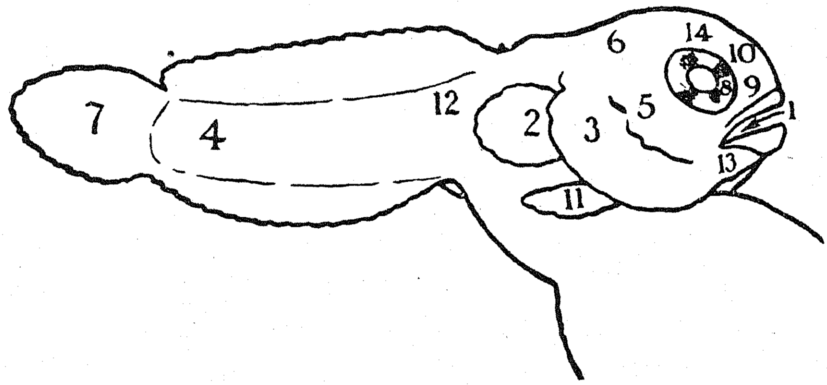


FIGURE 2

Diagram of Toadfish Larva to Show by Numbered Areas the Approximate Temporal Order of Development of Tactile Reactions from Various Regions

(From H. L. Tracy's (322) "The Development of Motility and Behavior Reactions in the Toadfish [*Opsanus Tau*]." *J. Comp. Neur.*, 1926, **40**, 295. By permission of the Wistar Institute, publishers.)

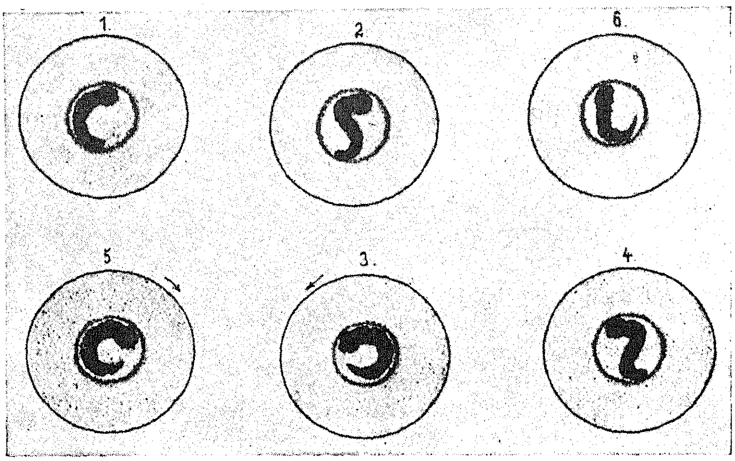


FIGURE 3

DIAGRAM OF VARIOUS POSITIONS OF FROG EMBRYOS *(Rana temporaria)* JUST BEFORE EMERGENCE FROM THE EGG

Note especially the C- and S-reactions.
(From W. Preyer's (277) *Specielle Physiologie des Embryo.* Leipzig: Greiber, 1885.)

In work on the development of behavior, however, the name of G. E. Coghill will always be especially associated with Amblystoma. It is with this organism that this investigator has done most of his original and brilliant work on the relationship between the developing structure and function.

Beginning in 1902 (59) and continuing to the present time (82), Coghill has published a most important series of papers on the development of behavior in relation to the embryology of structure. In the course of these papers Coghill has reported detailed studies of the development of the salamander and certain related types. The basic mechanism of behavioral development which he observes is very similar to the sketch of the development of amphibian behavior considered above as given by Preyer. Coghill has worked on many aspects of behavior, but for the purposes of this paper it may be well to emphasize his work on the development of aquatic and terrestrial locomotion and upon the development of the feeding reaction. In the development of aquatic locomotion Coghill notes a series of responses in Amblystoma which are in outline the same as those cited above in the work of Preyer, but the description given by Coghill is in much greater detail. Coghill shows that the first movement executed by Amblystoma is the bending of the head to one side. This is a response resulting from the contraction of muscles just behind the head. As the embryo advances in age, this contraction comes, after a period of gradual transition lasting about 36 hours, to involve the whole animal. The result of this, as previously noted by Preyer, is that the

organism assumes a position best described as a tight coil. This C- or exaggerated-C-coil may be to the right or to the left and may reverse instantly. At this period it is noted that all behavioral activities start at the head region and progress toward the tail. Coghill points out that "nothing really new has yet been introduced into the behavior pattern of the animal, since its first movement was performed, and the coil reaction gives the animal no locomotor power. Nevertheless, the coil has in it the primary locomotor factor: cephalocaudal progression of muscular contraction" (76, p. 6). The transition from this condition to the S-reaction of Preyer noted above is simple. One contraction begins to the left, and before this contraction has reached the tail another contraction to the right has begun. The nature of this movement may be made more clear in Figure 4. This reaction, as it gains speed, exercises a pressure on the water, and thus provides the basis of aquatic locomotion. It may be remarked at this point that this is apparently one of the most significant levels of description in the whole story of the genetics of behavioral development.

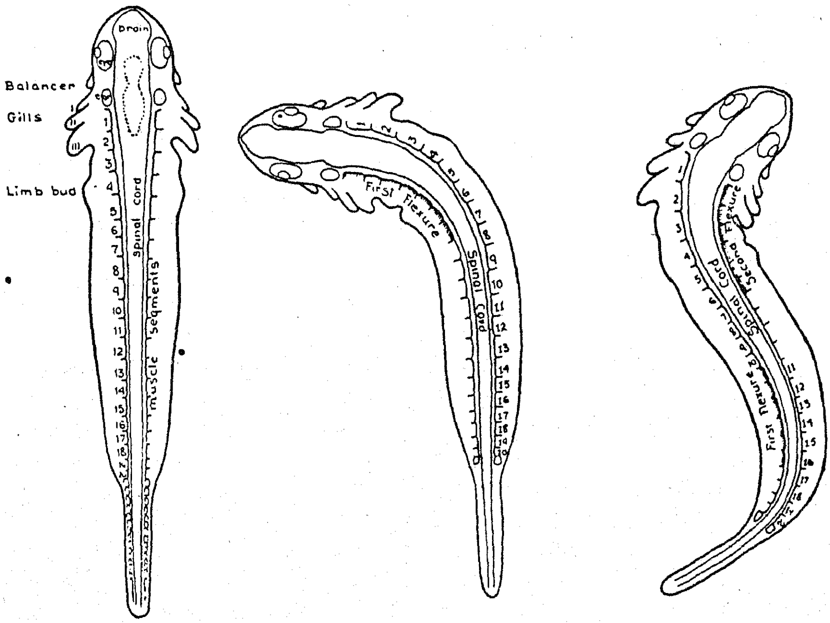


FIGURE 4

THREE DIAGRAMS OF AMBLYSTOMA

The diagram at the left shows the organism in an early swimming stage but without indication of muscle contraction. The diagram in the middle illustrates the beginning of a swimming movement as a first flexure by contraction of a number of anterior muscle segments, indicated by cross-hatching. The diagram on the right illustrates the swimming movement in which the first flexure has passed tailward and the second flexure is beginning in the anterior region.

(From G. E. Coghill's (76) *Anatomy and the Problem of Behavior*, pp. 7-8. By permission of The Macmillan Company, publishers.)

It will be seen, indeed, that this mechanism, particularly in its time relationships, is a response which may be thought of as a significant stage through which many of the higher forms pass during their respective developmental sequences. It is probably seen most clearly in the swimming vertebrates, possibly a little less clearly in four-legged mammals, and possibly still less clearly in man, but, in spite of this, it will become apparent as the chapter progresses that this is a very significant stage in behavioral development.

Coghill has summarized in five stages the sequence of development of this basic activity which he calls "aquatic locomotion." The stages of this development may be presented as follows: (*a*) The non-motile stage. In this stage direct muscle stimulation by mechanical or electrical means leads to muscular contraction and hence to externally observable response. (*b*) The early C-flexure stage. In this stage light touch on the skin of any portion of the body leads to a response. (*c*) The tight-coil stage. In this stage the contractions noted in stage (*b*) become more pronounced and the extent of the contraction greater. (*d*) The S-reaction, which is characterized by a reversal of flexure before the previous flexure has been completely executed as a coil, thus leading to the sinuous behavior of the total organism. (*e*) The speeding-up of the S-reaction so as to produce the typical swimming movement of the amphibian larva. Coghill considers in detail the neural structure of each of the five stages noted above. He then attempts in theoretical terms to show how the known structure of the nervous system may be considered to determine the behavior he has previously noted. This aspect of Coghill's work will be considered at the end of the present chapter, when the mechanism of behavioral development in all forms is reviewed. It should be pointed out that Coghill believes that in early organisms movement is typically away from the point of stimulation (76, p. 13).

As noted above, besides aquatic locomotion, the Amblystoma has other significant behavior systems. Of these, terrestrial locomotion and feeding merit especial consideration. The Amblystoma swims before its morphological development has progressed to the point where it has any true appendages. Both structurally and functionally the forelimbs, which develop after this time, are in advance of the developing hind limbs. At first, however, both sets of limbs when they appear move only in relation to the total trunk movement typically described above as swimming. Coghill believes that this may be explained in terms of nerve innervation. Gradually, independence of limb action or *individuation* of behavior over what Coghill characterizes as the dominance of the trunk movements begins (81, p. 638). First the forelimbs gain a certain autonomy, and then the hind limbs. "It is obvious," observes Coghill, "therefore, that the first limb movement is an integral part of the total reaction of the animal and that it is only later that the limb acquires an individuality of its own in behavior" (76, p. 19). The development of the forelimb itself follows the same general pattern of individuation. First the total limb moves;

then elbow flexion gradually appears. The wrists and the digits in turn gain independence of the total member. During this developmental sequence of the limb the time relations of the swimming reaction seem to be superimposed upon limb activity, so that the alternate movements of walking are in a sense to be considered as an integral part of the basic trunk movements which have been previously described. Thus Coghill remarks that "movement of the trunk in walking is nothing more nor less than the swimming movement with greatly reduced speed" (76, p. 25). Gradually the sinuous movement of the trunk becomes reduced as walking becomes more perfect, and eventually the characteristic land locomotion of the salamander is established. In a similar manner he traces the development of the feeding reaction in this same organism. He points out that this reaction, beginning first with the movement of the trunk, developing through successive stages to include a sudden lunge of the whole organism and the gradual correlation with this lunge of movement of the jaws and the muscles of the esophagus, follows. In conclusion Coghill says, "Behavior develops from the beginning through the progressive expansion of a perfectly integrated total pattern and the individuation within it of partial patterns which acquire various degrees of discreteness" (76, p. 38). As this development continues, various sensory fields become important in relation to the form of behavior. The extent to which such responses are to be considered as direct effects of receptor stimulation and the general mechanism of individuation will be considered at the end of the chapter after a general review of the fetal senses has been presented. It should be noted, however, that his study of the part played by the mechanism of association, particularly in relation to the peripheral sensory system, convinces him that "the individual acts on its environment before it reacts to its environment" (78, p. 345).

In a series of papers, the present writer has presented the results of studies of the development of behavior in Amblystoma and the frog under conditions such that experimental groups of animals were raised under unusual environmental conditions (47, 49-51). Following a technique devised by Randolph (279) and developed by Harrison (135), several series of organisms were raised under an anaesthetic. For a consideration of the effect of this anaesthetic on organisms the paper of Matthews and Detwiler (228) should be consulted. At a period before motility had begun, a large number of developing Amblystoma were separated into two groups, one a control group and another an experimental group. The experimental group was placed in water containing a solution of chloretone. The control group was allowed to develop normally in water. Eventually, at a point previously noted by Herrick and Coghill (143), extended responses began in the control group. The experimental group showed morphological development; otherwise they remained absolutely inert. However, in a short time after the drugged embryos were placed in fresh water they began to swim well. "In fact, a number of the eighteen Amblystoma embryos swam so well in less than one half hour after they

had shown the first sign of movement, that they could with difficulty, if at all, be distinguished from the members of the control group who had been free swimmers for five days" (47, p. 55). In later experiments efforts were made to control stimulation in other ways (50). As a result of these experiments the conclusion is made that the results show that the development of the mechanism upon which behavior depends occurs in these organisms when such organisms are not subject to continual external stimulation, as would apparently be demanded by an extreme interpretation of the environmental determination theory of Child (54). On the other hand, nothing in these experiments is taken as demonstrating or, indeed, as dealing with the problem of the nature of intra-organic response and stimulation. Such intra-organic responses of cells and groups of cells are more and more seen to be important in the development of the mechanisms on which later bodily behavior is to depend. Increasingly, such studies as those of Burr (41) on this same organism, concerning an electrodynamic theory of development, suggest an inner dynamics of development in the response mechanism which is in many respects essentially a stimulus-response relationship between the cellular elements of the growing nervous systems and associated structures. The significance of an understanding of this inner dynamics of growth for an understanding of behavior is considered below.

Turning from the amphibians to the reptiles, we find a class in which, so far as the present writer has been able to learn, comparatively little developmental work has been done. Preyer, however, reports some casual observations on the development of behavior in snakes (277, p. 404).

III. The Development of Behavior in the Embryos of Birds

According to the usually accepted scheme of evolution, the bird may be thought of as presenting an interesting comparison with the lower vertebrate and the mammal. Certainly it stands between these two sets of forms in the ease with which it may be studied as it develops. As we have already seen, the amphibian embryo provides unusually favorable material for developmental study. The growing frog or salamander embryo may be observed, without interference of any sort, through its translucent egg covering and in free life after leaving these coverings. On the other hand, as we shall point out below, the study of the development of behavior in the mammal involves a relatively complex operation, and at present, at any rate, a certain disturbance of the normal environment of the growing organism. The bird's egg is harder to study than the amphibian but easier than the mammal. It may be studied in a relatively normal environment, but a special technique is necessary to render the development of the bird fetus continuously observable. Down through the years, however, the chicken's egg has been the subject of embryological study. Needham reviews in various places the use that has been made of the hen's egg in embryology since earliest times (248, pp. 46-367). This writer deals with the history of artificial incubation of hens' eggs. He

notes also the beginning of systematic observation on embryos taken from eggs in various periods of incubation at the time of Hippocrates (about 460 B. C.). From that time on, the hen's egg has been extensively used in morphological studies on development. Among those having contributed to this development are Aristotle, Aelian, Pliny, Plutarch, Albertus Magnus, Leonardo da Vinci, Aldrovandus, Fabricius (who gave beautiful illustrations of a series of chick embryos), Highmore, Sir Thomas Brown, Harvey, and Malpighi. From this time down to the many admirable manuals on the embryology of the chick, such as those by Patten (264) and Lillie (212), a vast amount of evidence in regard to the structural development of the chick has been brought together.

Reviewing certain of these facts, Preyer noted almost fifty years ago that, while the structural development of the chick is comparatively well known, its behavioral development is not comparably well known. Although advances have been made, this observation is still true. A few casual observations on this development, nevertheless, were made early. Harvey as long ago as 1651 noted that the chick in the sixth day of development showed a bending and stretching of the head (277, p. 405). About a century later Béguelin noted the heart beat of the embryo on the third day, and on the sixth day the oscillation of the whole body, and from that point on he records elaborate changes in movement. He records the fact that he was able to observe the development for fifteen days in the same living and developing embryo (277, p. 405). Home, in 1822, was probably the first to note the movement of the extremities on the sixth day (277, p. 405). Von Baer, in 1828, published rather extensive studies on the development of behavior in the chick, in which he noted the inception of the pendular movement of the whole fetus as a result of amnion contractions. Amnion contractions, he noted, were most marked at the eighth day and were successively less on the succeeding days. On the eleventh, twelfth, and thirteenth days this same investigator reported general activity of the embryo. He also saw what he considered to be the beginning of breathing movements in the fourteen- to sixteen-day embryo (277, p. 405). Several other investigators are quoted by Preyer as having also made observations upon the development of behavior in the chick. By far the most extensive study up to his time, however, on the development of the bird embryo was made by Preyer himself. Something of the extent of his study may be indicated by the fact that he used some five hundred eggs in his experiments.

In this work, Preyer gave much attention to the movements of the amnion which have been already referred to above. These movements, so far as a general understanding of development is concerned, are peculiar in that they occur, in the form described, only in eggs. Preyer pointed out that the rhythmic movement of the amnion, when at its maximum extent, between the seventh and ninth day, leads to such an agitation of the fetus that no study of fetal activity could be made without taking these contractions into account. Preyer also considers the gradual develop-

ment of behavior of the chick embryo from its earliest head movement to the behavior necessary for hatching (277, pp. 408-416, 555-585). Since the time of Preyer there have been a number of special studies on particular aspects of the fetal and hatching behavior of the bird, such as those by Clark and Clark (58), Breed (35), and Craig (94). For the purposes of this paper by far the most important work that has recently appeared in this field is that of the psychologist, Kuo, which is presented in a series of papers (187-191).

In order to collect material for the study of the morphological development of the egg, it is necessary only to open the shells at known periods of incubation. Such opening of the egg without special precaution leads to the early death of the embryo. A number of techniques, however, have been devised for the continuous observation of the early development of behavior in the bird. The most recent method, devised by Kuo, seems to have yielded excellent results. The method of this investigator makes possible an uninterrupted study of the developing fetus without interfering in any essential way with the membranes of the egg. Kuo's operation may be described as follows: The shell of the blunt end of the egg is cut off with a fine pair of scissors as far as the inner membrane. The whole inner membrane, however, is allowed to remain intact. Melted vaseline is immediately and rapidly applied to this membrane by the use of a Chinese writing brush. At the temperature of the incubator, the vaseline remains liquid. This treatment produces a clear transparent membranous window through which the embryo and the extra-embryonic structures and functions can be observed. The author states that this technique renders the membrane so transparent that it is just as good as removing the membrane. In the course of observations Kuo uses three incubators, one in which the eggs are kept before they are experimented upon, another in which the operation is performed, and the third a special observation incubator fitted with appropriate glass plates through which a microscope may be used. Kuo (187) has also devised a transparent dial graded in fractions of a millimeter which may be put over the cut end of the egg, thus making the quantitative measurement of fetal movements possible.

Using this technique, Kuo has studied over three thousand eggs, and on the basis of this study he has made definite statements in regard to the developmental sequence of behavior in the chick embryo. This work deserves special consideration in this chapter because of the fact that it is the work of a psychologist, and because it places an emphasis on the part played by the environment in the determination of the course of behavioral development. The results are also presented in such a way that they are peculiarly applicable to psychological problems.[1]

Kuo has traced the chronology and general nature of behavior in the chick embryo (187), the mechanical factors in the various stages leading

[1]The present writer has personally studied amphibian and mammal but not bird fetuses. He therefore feels himself less competent to give a personal evaluation of Kuo's work than of the work that has been done on other types.

to hatching (188), the influence of prenatal behavior upon postnatal life (190), and other special topics. A reference to Figure 1 above will show that at one typical stage the fetus of the chick is very similar to the fetus of the reptile and, indeed, of man. It must, however, be understood that the arrangement of the fetus of the bird in relation to its extra-fetal membranes is in a number of ways peculiar. A description of this anatomical relationship can be found in Patten (264).

Kuo has made an elaborate quantitative study of all behavioral stages of the fetal behavior of the chick. This work may possibly best be given in summary by indicating briefly something of the observed movement and the time at which the movement was *first* observed. It should be noticed that the present writer, by using the time at which the movement was first observed, may do an injustice in certain cases to the facts as presented by Kuo, because that investigator shows that in many cases the movement does not, on the average, arise until some hours or even days after it was first observed in peculiarly favorable specimens. A summary of the commencement of the passive and active movements characterizing the developmental behavior of the chick may, however, give the best generalized picture of the development of the chick that is possible in the compass of this chapter. The following activities are among those noted: heart beat, 36 hours; head vibration, 66 hours; body vibration, 66 hours; head-lifting, 68 hours; head-bending, 70 hours; trunk movement, 84 hours; amnion contraction, 86 hours; yolk-sac movement, 86 hours; swinging, 88 hours; head-turning, 90 hours; movement of forelimbs, 90 hours; movement of hind limbs, 90 hours; movement of tail, 92 hours; movement of toes, 5 days; response to electricity (in an embryo removed from the shell and placed in a physiological salt solution), 6 days; eyelid movement, 6 days; response to pressure, 6 days; movement of eyeball, 7 days; swallowing, 8 days; leg-folding, 9 days; fixation of body position, 9 days; bill-clapping, 9 days; response to touch (in physiological salt solution), 9 days; first wriggling, 11 days; turning of body, 12 days; protrusion of neck, 16 days; respiratory movement, 16 days; response to rotation, 17 days; tearing of membrane, 17 days; peeping, 17 days; response to light, 17 days; response to sound, 18 days; response to vibration, 18 days; hatching, 19 days. Final leaving of the shell does not typically occur, however, until the twentieth or the twenty-first day (187). Kuo has not been content with a mere passive description of the movements indicated above in their time sequences, but in every case he has attempted to give a description of the mechanical and environmental factors which are important in determining the special movements and the special modifications of movements that he notes. Thus, for example, he points out that the beating of the heart leads to a general rhythmic vibration of the inert fetal body which starts the head into passive mechanical movement. This passive mechanical movement continues until at length it gives place on the fourth or fifth day to a true active movement. Head movement begins as an up-and-down bowing. Gradually, as a result of the change of the weight of the head and of associated structures

in the egg, this up-and-down movement is changed to a sidewise movement, which is eventually inhibited by the altered relationship between the fetus and the yolk-sac. He makes similar observations in regard to the movement of the appendages and to other special behavioral functions. He notes especially the interrelationship, already suggested by Preyer and earliest investigators, between the movement of the amnion and the embryo. It should possibly be noted parenthetically, that, although extra-embryonic, the amnion contains true muscle fibers and is at one period of development in almost continuous rhythmic contractile activity. During the period of the most forceful amnion activity, from the seventh to the ninth day, its contractions lead to a large increase in the active movements of the embryo itself. These movements are considered as significant in the development of further movement. It is also noted that an active movement of the embryo may incite further activity of contraction in the temporarily relatively quiescent amnion. Indeed, possibly as a result of this reciprocal activation during the period of vigorous amnion contractions, the movements of the developing chick are almost ceaseless. It thus comes about that every part of the musculature of the embryo has been exercised before half of its incubation period is over. This fact leads Kuo to point out that any correlation which it is desired to make between the development of behavior and the development of the nervous system must take into especial consideration the changing conditions of response due to morphological growth and increase in weight of the body parts themselves and especially to the changing relationships between these growing body parts and the environment in which the growth is taking place (188). It is interesting to note that the specialized movements of the eye and of the eyeball occur as early as the eighth or ninth day, but that the first light response of the organism does not ordinarily appear until the seventeenth to the nineteenth day under experimental conditions. Thus the eye reflexes are present in the absence of all effective visual stimuli. These early eye movements have been found, indeed, by Kuo to occur in conjunction with movement of the body in space instead of in response to visual stimuli. The similar condition in mammals and its probable mechanisms will be considered below. Only in the later periods of development do the eyes begin to acquire a relative degree of independence from the rest of the movements of the organism. In general, Kuo reports that the responses to touch, pressure, and electricity, which may be elicited from at least the tenth day onward, are similar to the normally excited responses which he has for the most part observed. In conclusion, Kuo asserts that practically every physiological effector mechanism is thus shown to be in a functional condition long before hatching and that the organs begin to function in many cases before they reach adult form; indeed, many function in rudimentary form. As is the case in the development of structure, he feels that too much stress cannot be laid on the fact that the development of behavior is gradual and continual. In his opinion, at any rate, the early embryonic movements may be thought of as the elements out of which

every later response of the adult bird is built. Indeed, in this connection he has been able to point out that certain of the typical postural attitudes of the adult fowl are but returns to the tonus condition of the attitudes of prehatching life (190, p. 113). This same observation, incidentally, although too infrequently presented, can be made in the case of mammals and man, and as such will do much to explain the maturation of many allegedly saltatory behavior patterns of postnatal life.

Kuo's general views (191) in regard to the origin of behavior in relation to environmental interference and in relation to the intensity of stimulation and in regard to the problem of individuation versus integration of behavior will be considered at the end of the chapter where it will be possible to evaluate his views in connection with the general problems of human behavioral development.

IV. The Development of Prenatal Behavior in the Infrahuman Mammal

The development of behavior in the infrahuman mammal is in a number of respects more significant for one who would understand the growth of psychological functions in man than is the consideration of the amphibian or bird presented above. There are peculiar difficulties, however, in studying the development of behavior in mammals. These difficulties can be made clear only by a brief review of the bodily structures and functions involved in the prenatal development of a typical placental mammal, including man. In barest outline, disregarding many differences between various species of such mammals and many consequent qualifications, this process of development will be reviewed in the following few paragraphs.

The tiny fertilized egg is not at first attached, but, probably as a result of ciliary action and the muscular contraction of the tubes, moves from the oviduct where it has been fertilized to the uterus. During the process of movement, which occupies from four to ten days, depending on the type of mammal under consideration, the processes of development have begun which are to form the embryo and its membranes. Two embryonic folds are early formed which join to make up the then enclosing amniotic sac. This sac gradually enlarges and is filled with a special liquid, the so-called amniotic fluid, which has a very definite chemical make-up and a specific gravity of 1006-1081 (118, p. 139). This liquid is thus approximately of the same specific gravity as the developing fetus, a fact of great importance in understanding the mechanics of certain forms of receptor–nervous-system–effector action. As growth continues, the sac more and more completely surrounds the embryo. The fetus thus immersed and supported is relatively independent of most direct mechanical surface contacts. Coincident with this development, the other fetal sacs are formed. One of these, the vitelline sac, corresponds to the yolk-sac of lower forms, although of course in the higher mammalian types it contains virtually no yolk. In later development of the fetus this sac is relatively much reduced in size and at the time of birth is known as the umbilical vesicle. The

allantois also makes its appearance as an outgrowth of the developing digestive tract of the embryo. This sac-like structure comes in contact with a previously formed structure, the so-called primitive chorion, with which it fuses to make up the true chorion. This doubly derived chorion now rapidly becomes a completely enclosing membrane wall outside the amniotic sac. The chorion continues to be attached to the embryo proper, however, by means of the allantoic stalk, which comes to conduct as well the two allantoic arteries and the two allantoic veins.

As this development has progressed, therefore, the at first free-moving product of conception has become attached to the wall of the maternal uterus. As the very complex histological changes, some of which have been suggested above, take place, the circulatory system of the fetus and its membranes continues to develop. This fetal circulatory system is mechanically completely separated from the maternal blood system, but the separation is, in certain areas, only that of a thin protoplasmic wall. By interchange through living membranes, therefore, oxygen and food materials pass from the maternal blood system into the independent embryonic blood system; similarly, carbon dioxide and other metabolites pass in the opposite direction into the maternal blood stream. Typically, in the higher mammals, only part of the chorion is thus directly attached to the

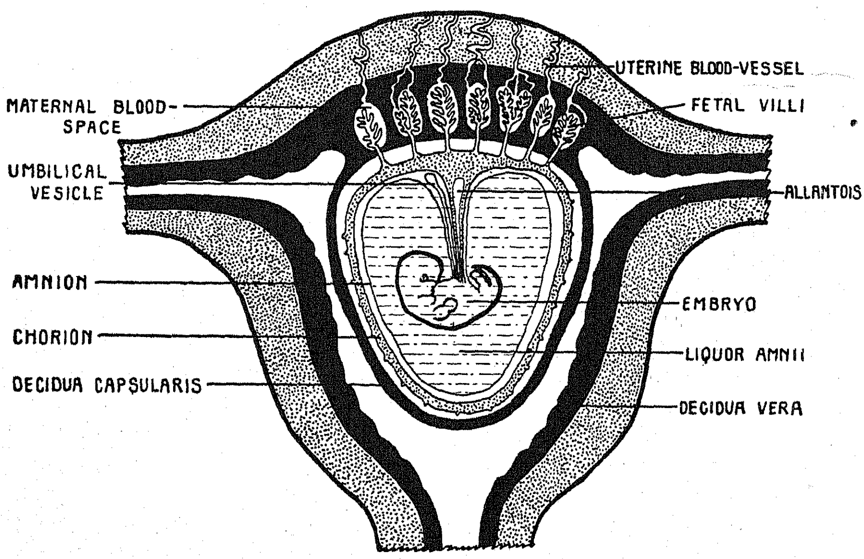


FIGURE 5

DIAGRAM REPRESENTING THE RELATIONSHIP BETWEEN THE UTERUS, THE MEMBRANES, AND THE EMBRYO DURING EARLY PREGNANCY

maternal uterus. This area of attachment is called the placenta. The placenta may best be thought of as involving two parts, one of which is derived from the fetus and one of which is derived from the maternal uterus. That which is derived from the maternal uterus becomes larger and larger, eventually encapsulating the developing embryo and its membranes which have just been described. This true maternal membrane, as distinguished from the previously considered fetal membranes, is called the *decidua capsularis*. In human development, as the fetus grows, this *decidua capsularis* comes to be in contact with the mucous-membrane lining of the rest of the uterine cavity, the so-called *decidua vera*. Thus the fetus becomes enveloped in an elaborate series of membranes. Figure 5 shows these relationships in schematic form in the human organism. These developed membranes provide within the mother's body a strong, many-layered sac in which is maintained an aquatic environment of very constant temperature and remarkably constant physical and chemical constitution. For an elaborate consideration of this development made clear by excellent diagrams see Spee (298).

By means of the association at the placenta, as just noted, the independently developing embryo is able, parasitically as it were, to receive food materials, oxygen, and other needful substances from the maternal blood supply and to send back into that system the waste products of its organic life. The mechanism of the fetal membranes, therefore, makes possible fetal respiration, nutrition, and excretion. It is in a physical world of this sort that we must consider the fetal mammal as developing and in its later stages as actively responding. The nature of this environment must not be forgotten in considering every evidence of sensory or behavioral life which the fetus shows.

Birth consists in the rupture of these membranes produced by the contractions of the muscular walls of the uterus. A short time after the birth of the young mammal or the child follows the expulsion of the now discarded enveloping membranes. This "after-birth" consists largely of the remains of the decidua, the chorion, and the amnion. In infrahuman mammals this afterbirth is customarily eaten by the mother (319).

From what has been said, it is obvious that the developing mammal is so well protected that it is difficult to study its growth at different periods, and well-nigh impossible—although the "impossible" has been accomplished, as will be pointed out below—to observe continuously the development of the same mammalian fetus. Kuo has, with ample justification, recently pointed out the dangers of generalizing upon the nature of fetal development on the basis of observations made under abnormal conditions (189, p. 265). In the nature of things, however, most observations on the mammalian fetus must, in some sense at any rate, ordinarily be abnormal, because the very protection which is provided by the fetal membranes just

considered must be destroyed if observation is to be possible. It will, of course, be impossible to give an account of the development of behavior in all classes and orders of mammals. Indeed, no special studies have been made of most mammalian forms in this connection. For example, so far as the writer is aware, no special study has been made of the development of behavior in the fetal monotremes. The study of the development of behavior in these primitive Australian egg-laying mammals would probably provide fundamentally significant facts that might be applied to higher truly viviparous forms. In both ornithorhynchus and in echidna, eggs with soft shells, rich in yolk, undergo segmentation in the uterus and are then laid and incubated. The incubation by ornithorhynchus is in a nest, by echidna in a pouch. When hatched, the young of this subclass are nourished by the secretion of great glands more like sweat glands than the true mammary structures of higher mammals. But a detailed description of this process is not, so far as the present writer can discover, available.

Study of the development of behavior in what is generally considered as the next higher subclass to the monotremes, namely, the marsupials, has been carried on. Indeed, the marsupials are found to be very favorable material for developmental studies, for the young are born in a condition which can be considered only that of a relatively immature fetus (200). In the animals of this subclass, while early development occurs in the maternal uterus, and while the fetus is nourished by secretions from the uterine wall, no true placenta is formed. Possibly for this reason in such animals the fetus is quite anatomically immature when it is born. In animals of this class, therefore, mammalian fetuses are born which, while still at an early period of development, are still open to easy continual external observation at various stages. This fact has made this form a favorite one for studies of neurological development by such students as Langworthy (200) and Weed and Langworthy (332, 333). After birth they are cared for by the mother for many weeks in a pouch, the marsupium, into which the mammary nipples open (140). In certain of the marsupials, indeed, the once independent fetus again becomes functionally but not structurally attached to the mother, as for a long period after first taking the maternal nipple into the mouth the nipple is never removed (140, p. 260). From the standpoint of the student of the development of behavior the most adequately studied form of this subclass is the Virginia opossum. In a series of papers Hartman (136-140) has brought together the knowledge in regard to the development of the fetus in the opossum and related types. Until his own work was commenced, he points out that the birth of the opossum and the behaviorally significant journey of the newborn organisms to the pouch had been observed and published by but one man, Middleton Michel. Michel's observations, which are reprinted by Hartman, led to a belief that the mother transferred the newborn animals to the pouch. Hartman's work, however, has shown that the newborn organisms travel directly from the vulva to the maternal pouch without the aid of the mother. He says:

"Unerringly the embryo traveled by its own efforts; without any assistance on the mother's part, other than to free it of liquid on its first emergence into the world, this ten-day-old embryo, in appearance more like a worm than a mammal, is able, immediately upon release from its liquid medium, to crawl a full three inches over a difficult terrain. Indeed, it can do more: after it has arrived at the pouch it is able to find the nipple amid a forest of hair. This it must find—or perish" (140, p. 255).

Hartman has further shown that this essential journey is to be considered as a negative geotropism, because under experimental conditions embryos can be made to travel away from the pouch if only the skin upon which they are moving be tilted upwards. The locomotion of the embryo is described as a kind of overhand swimming stroke in which the head sways as far as possible to the side opposite the hand which is taking the propelling stroke. It is further noted that "with each turn of the head the snout is touched to the mother's skin . . . and if the teat is touched the embryo stops and at once takes hold" (140, p. 256). A conclusion may be made, therefore, that this young mammalian organism, less than two weeks removed from an unfertilized ovum, has already developed to a point of independent ability so far as air, respiration, alimentary-canal digestion, and the receptor-neuro-muscular mechanism of geotropically orientated simple progression are concerned.

Goerling, in an article reprinted by Hartman (140, p. 257), gives an account of the birth of the kangaroo, an animal of the same subclass as the opossum. It has been observed that in the kangaroo the young animal moves through the fur from the opening of the urogenital canal to the pouch. The following observation is recorded in regard to the fetus: "It moved about slowly, very slowly, through the fur, upwards, using its arms in its progress and continually moving the head from side to side . . ." (140, p. 260). Thirty minutes were required for the passage, but during this time the mother gave no assistance whatsoever. This same observer further notes that the arms of the newborn kangaroo are strongly developed. The small hands open and close like a cat's paw. He says: "By these strong little arms and hands the young one is enabled to labor its way to the pouch, the place of safety and nourishment" (140, p. 260). It is further pointed out that, so far as the sucking reflex is concerned, once a young kangaroo is removed from the teat which it has taken in its mouth it is apparently unable to reattach itself. Figure 6 shows the early fetal appearance of the pouch-young kangaroo (261, p. 577).

In the series of papers referred to above, Hartman reports his studies of the early embryology of the opossum, but without any detailed reference to the onset and development of behavior before the early motility stage in which it is found at birth. It is interesting to note, however, on the basis of the evidence given above, that in the marsupials young organisms which might well be called embryos are born in what is in many respects an early fetal condition. Their behavior, as indicated above, is significant

FIGURE 6

A So-called Mammary Fetus of the Kangaroo Attached to the Maternal Teat

(From T. J. Parker and W. A. Haswell's (261) *A Text-Book of Zoology, Vol. II,* p. 577. By permission of The Macmillan Company, publishers.)

in a number of ways for the general student of the development of response, because it can be studied without the usual difficulties of disturbed respiration and digestion of higher mammalian fetuses of comparable developmental age. The reports just given suggest that in this organism there is a general conformity with the pattern of development of the amphibian larvae considered above. As in Amblystoma, the young opossum moves with a wriggling movement which from the description, ". . . the head swaying as far as possible to the side opposite the hand which is taking the propelling stroke," suggests the double-S-movement first described by Preyer and elaborated by Coghill and others as a characteristic of the onset of aquatic locomotion in larval amphibians. It is also significant to note that it is the forelimbs, both in the opossum and even in that characteristically hind-limbed organism, the kangaroo, which are mentioned as the effective agents of locomotion. This again confirms the general view that behavior develops from the anterior to the posterior segments of the organism, a generalization which we have seen to be essentially true in regard to invertebrates, amphibians, and bird embryos. Moreover, there is nothing in the development of the feeding reaction which is presented that shows its essential sequence to be different from that already noted in lower types. Langworthy (197, 200) and Weed and Langworthy (332, 333) have studied the development of progression and body posture in pouch-young opossums. They find that decerebration of young opossums does not lead to decerebrate rigidity, but rather to an increase in progression movements. Similarly, they note, after giving a complete review of the work on the nervous system of the opossum, that electrical stimulation of the brain of pouch-young opossums gave contralateral leg responses, but no other responses for over fifty developmental days (332, p. 23). These observations are important in regard to the part played by myelinization of the nervous system in behavior and, incidentally, seem to

confirm the dominance of forelimb progression in the early behavioral repertory of this form.

Of all orders of infrahuman mammals, the rodents have probably been most completely studied, so far as the development of behavior is concerned. It is difficult to say when the study of behavioral growth in rodent fetuses began. They are convenient animals to work upon, and it is highly probable that some member of this order was used by the classic embryologists, whose work will be historically reviewed below when a discussion of the specific development of behavior in man is given. It is known, at any rate, that the dead embryos of typical rodents, namely, the rabbit, guinea pig, and mouse, besides many other animal forms, were discussed by Hieronymus Fabricius and published in his monumental work, *De Formato Foetu,* in 1604 (248, p. 115). It is highly probable that this writer or some of the other great embryologists of the Renaissance observed the behavior of fetal rodents, because at this time embryology was still much concerned with the Aristotelian problem of the development of the vegetable, sensible, and rational soul in all the forms which were studied. The first important experimental study of the development of behavior in this order, however, that the writer has been able to find is that of Bichat, which was published by him in Paris before 1818 (21-23). This physiologist experimented upon the living embryos of a number of animals, particularly in studying the relationship between the blood stream of the mother and the fetus. In this work he extensively used the guinea pig. As a result of his studies Bichat came to a number of interesting, and to some extent unsound, conclusions in regard to the fetal development of behavior. He presents a generalized thesis, possibly growing out of the speculations of the Renaissance, that the organism at all stages combines what he calls two lives, one of which is that of sensibility, involving the brain and the senses, and the other that of the vegetative life, involving digestion, circulation, and the like. On the basis of his researches on fetal behavior he concludes that the life of sensibility does not begin before birth, although he notes and describes in some little detail the nature of fetal movements. He alleges that the fetus must be thought of as living in a world virtually devoid of stimulation, as he holds that an energy, in order to be a stimulus, must change. As the fetus is held in a liquid of constant temperature and properties, he contends that it is virtually unstimulated. He does admit that the sense of touch may be stimulated before birth, but it is not, he further contends, really touch, as every true sensation supposes a comparison between a present and a past state of being. For this conclusion he is roundly criticized by the eminent French physiologist, Magendie, who later edited Bichat's work. Magendie says in a footnote to Bichat's statements on touch that, "whatever Bichat may say, it exists in the fetus before birth." Bichat himself, however, points out that touch is to be considered as the most fundamental of the senses and suggests that "philosophers say it is the only one of the senses which always is the agent of truth" (22, p. 136). Against this

sweeping generalization Magendie, the scientist, in another footnote, quotes the old experiment of Aristotle upon the illusory localization of the crossed fingers (22, p. 137). Partly on the basis of his work on guinea pigs, Bichat concludes that the responses of the fetal organism develop continuously from zero to a point of greatest activity just before birth. He supports this conclusion by much anatomical evidence which includes a discussion of the musculature of the limbs, the brain, the nerves, and the sense-organs. He then attempts, as it might almost seem, to explain away the observations which he has just made, in the light of his own theory. For he at once asserts that the existence of the fetus is not that of an animal but virtually that of a vegetable. This conclusion is based upon the dichotomy which he attempts to establish even in the adult life of man between movements which are dependent upon the will and hence "animal" as contrasted with the movements such as those occurring in sleep which he alleges are not animal but merely "living."

It is a long step from these early theories and observations to the present knowledge of the development of behavior in rodents, and indeed this step was not taken in a single jump. In 1818 Emmert (114), an embryologist, and a collaborator, published certain observations on the behavioral activity of field-mouse embryos. In 1877 Zuntz (354) again used fetal rodent material in a series of scientific observations. His work was devoted for the most part to a consideration of the chest movements of the newborn fetus of the rabbit, which was used in part of his study of the development of fetal respiration in mammals.

It was not, however, until Preyer began his series of experiments on fetal guinea pigs that the modern period of study in regard to behavioral growth in rodent and, indeed, in mammalian fetuses may be considered to have begun. In his summarizing work of 1885, Preyer often gives an elaborate history of the previous work in regard to the study of the development of behavior in each form which he considers, but, significantly enough, in his treatise on the development of mammalian behavior he begins almost without historical references.

Preyer, in his own experiments, however, used a number of different types of mammals and a number of different techniques in his study of the development of behavior (277, pp. 416-428). His most significant work was done on the guinea pig. In studying this rodent he used at least the following six methods: (*a*) The animal was placed on its back and the movements of the external abdominal wall of the pregnant mother animal were observed without interference. He also made such observations on pregnant females on which so-called "animal hypnosis" had been induced by an appropriate posture and pressure manipulation. As a result of these types of direct observation he concludes that there are periods of quiescence sometimes lasting for more than an hour interspersed with periods of great activity in fetal actions, at least during the latter part of the pregnancy. (*b*) He placed a long, thin needle directly through the abdominal wall and the fetal sacs of the pregnant female into the fetus.

This needle was so inserted that when the fetus moved, the needle could be observed to change its position. As a result of this sort of study the frequency of fetal behavior in time was noted. (*c*) He listened to the fetal movements through a stethoscope and recorded that in the latter stages of pregnancy they made a peculiar *Knistern* and *Knacken*. (*d*) By operation he found it possible to allow a single limb to extrude from the sac in such a way that its movement could be observed. (*e*) By operation he was able to observe the movements of the fetus still in the mother's body. In this situation he was able to note the effect of changing the blood supply upon fetal behavior and to come to the conclusion that although deprivation of oxygen did lead to general fetal movements such deprivation was not an essential cause of such movements. (*f*) He also removed air-breathing guinea pigs and studied them when supported by blood-warm physiological salt solution and in a warm chamber. In observing the movements of such fetuses he characterizes their responses as "*sehr manigfaltig, ungeregelt, asymmetrisch, arhythmisch*" (277, p. 418). It will be interesting to note below that these are virtually the same words used by Minkowski in describing early human fetal movements. Preyer also observed certain movements of stretching and of reflex contraction and extension which would be difficult for the fetus while confined in the sac. This phenomenon has been seen many times by the present writer. There is no evidence that Preyer used any anaesthetics in any of the methods noted above, and therefore the criticism of the more humane work of later investigators, that possibly the fetal material was anaesthetized, cannot be urged against this pioneer work of Preyer.

In one case Preyer notes that, when his observations were made on a guinea pig in the still intact sac, touching against the skin of the face led to a localized brushing movement on the part of the forelimb of the fetus as if to wipe away the offending stimulus which was touching the pad of the vibrissae (276, p. 212). We shall see that the developmental study of this ability in the fetus may throw light upon certain aspects of the old question as to whether or not the perception of space is natively or empirically determined. Preyer gives a rather general description of development in the fetal guinea pig. In a fetus of 20 to 21 mm. in length no movement was seen, but he adds that this may not be interpreted as assuring the fact that no movement had previously occurred while the organism was in the uterus. In one of 81 to 83 mm., however, opened under blood-warm salt solution, the heart was seen to beat strongly, and chest movements were noted. In much larger fetuses, 105 to 111 mm., a complete repertory of action almost like that seen in the adult animal was recorded. Many other observations are given on fetuses the lengths of which are not recorded. On the basis of these observations, often approximately dated by statements in regard to the hair and teeth condition of the organism, it is possible to say that Preyer noted in the development of behavior in the guinea pig a change in response, from uncoordinated movements, up through a gradual development, to specific responses. In a series of care-

fully weighed litters in later stages he gives a detailed account of definite responses, including the pinna reflex to sound, the pupillary reflex to light, and even the cerebral inhibition of reflexes as a result of antagonistic stimuli (277, pp. 587-595). He points out that in a 173-gr. guinea pig the teeth of the organism were so well developed that they sharply bit his fingernail (277, p. 423). On a basis of this experimental work, Preyer turns to his consideration of the development of behavior in the human fetus, to which reference will be made below.

The most elaborate and systematic study of the development of fetal behavior in guinea pigs, from the point of view of genetic psychology, is that of Avery (13), carried out in the Psychological Laboratory of Stanford University. As a background for the study of prenatal development Avery carefully investigated the responses to stimulation shown by newborn guinea pigs. As contrasted with the naked and almost helpless neonatal marsupials considered above, the guinea pig is at birth in many respects structurally and functionally a mature animal. It is born with a sleek coat of fur. Its teeth are well erupted. Its eyes and ears are open. Its heart pulsations and breathing are continuous and regular. It is able to roll from back to side, side to back, and side to haunches. It can crawl, stand, and walk. "To the pinch stimulus applied to the foot it responds by kick or withdrawal of foot. The electrical stimulus elicits a muscular twitch, respiratory gasp and jump. It can execute the scratch reflex spontaneously or when stimulated in the facial region. Although muscular weakness is evident, the patterns of response show good coordination" (13, p. 264).

The sensory control of behavior has also progressed to a remarkable degree. Lid and pupillary reflexes are present. The newborn animal avoids objects without touching them as it moves about. The ears are functional, and total bodily movements and pinna twitches are elicited by appropriate auditory stimulation. Needle-pricks and heated objects lead to quick response. Olfactory stimuli evoke movement of the head. The complex movements of swallowing are well developed. So far as more integrated behavior is concerned, Avery reports that the young run together when separated from each other, run to the mother when separated from her. Somewhat similar observations were also made by Preyer (276, p. 93). The young lick themselves, swim when placed in deep water, chew shavings, and attempt to disengage a foot held by an observer. No retreat responses were noticed when young guinea pigs were placed with an adult white rat. The prenatal development of behavior of this almost Minerva-like organism is peculiarly interesting, as already suggested above.

Avery's work on prenatal development must be strictly evaluated, however, in terms of the rather special conditions which he employed in his experimental study. Abandoning the techniques used by some of the earlier investigators in mammalian behavioral development, Avery removed from the mother each fetus that he studied. He thus, of course,

intercepted placental circulation and therefore brought about all of the changes which have been found to result from oxygen deprivation and an increasing concentration of metabolites in the fetal blood stream. Observations were made on a large metal tray placed on a well-lighted observation table. "An electric heater of the reflecting type was placed nearby. It served to dry the young and to keep them warm. A temperature of 98° F. was maintained on the table." This technique provided that, so far as early embryos were concerned, not only were they studied without normal respiration, but in what was apparently a continually drying condition. The results of Avery's study, therefore, must be considered as a function of these special conditions, because previous studies have shown, and some of the writer's unpublished experimental observations adequately demonstrate, that many responses are possible in an aquatic environment which are quite impossible when the organism is first placed upon a solid surface in the air. Avery studied animals of gestation ages from 45 to 68 days. The lower point was chosen because, in Avery's opinion, "prior to this time responses are so slight as to be of little importance for this problem." This decision is in some respects surprising, because Preyer reported movement in fetal guinea pigs of much younger gestation age. Indeed, according to Draper's tables (110) and Preyer's own estimate (277, p. 588), the first of Preyer's fetuses moved when they were from 26 to 29 gestation days old. The present writer has seen movement in a 30-day fetus and expects as his work progresses to see movement in a still younger fetus. Avery's work, therefore, from the standpoint of the general problem of development, must be taken as significant of the development of behavior in the later stages of gestation. Indeed, it is probably most significant in regard to fetuses which have developed to the point that they can, under appropriate conditions, breathe and move without difficulty in an air environment. The conclusions of Avery's study, so far as the onset of special responses is concerned, are most adequately summarized in Figure 7 which is copied directly from Avery.

This same investigator also considered the question as to whether or not there is a distinction between the responses of fetuses taken from young and old mothers. He came to the conclusion that there is no significant difference in the maturity of response elicited from the fetuses of young and fully adult mothers (13, p. 311). This conclusion is unlike that of King (180) and Angulo y González (10) for the white rat, in which parental condition was found to influence fetal development.

By the use of X-rays Avery also studied the orientation of the fetuses in the uterus of the guinea pig. This study convinced him that gravitation is apparently not very significant in determining rapid changes in the orientation of the fetus in the uterus. He concludes: "The shifts of the fetuses in the uterus are inadequate to explain their rapidity after experimental delivery." As a final conclusion to his study, Avery says: "These results substantiate the belief that certain congenital response mech-

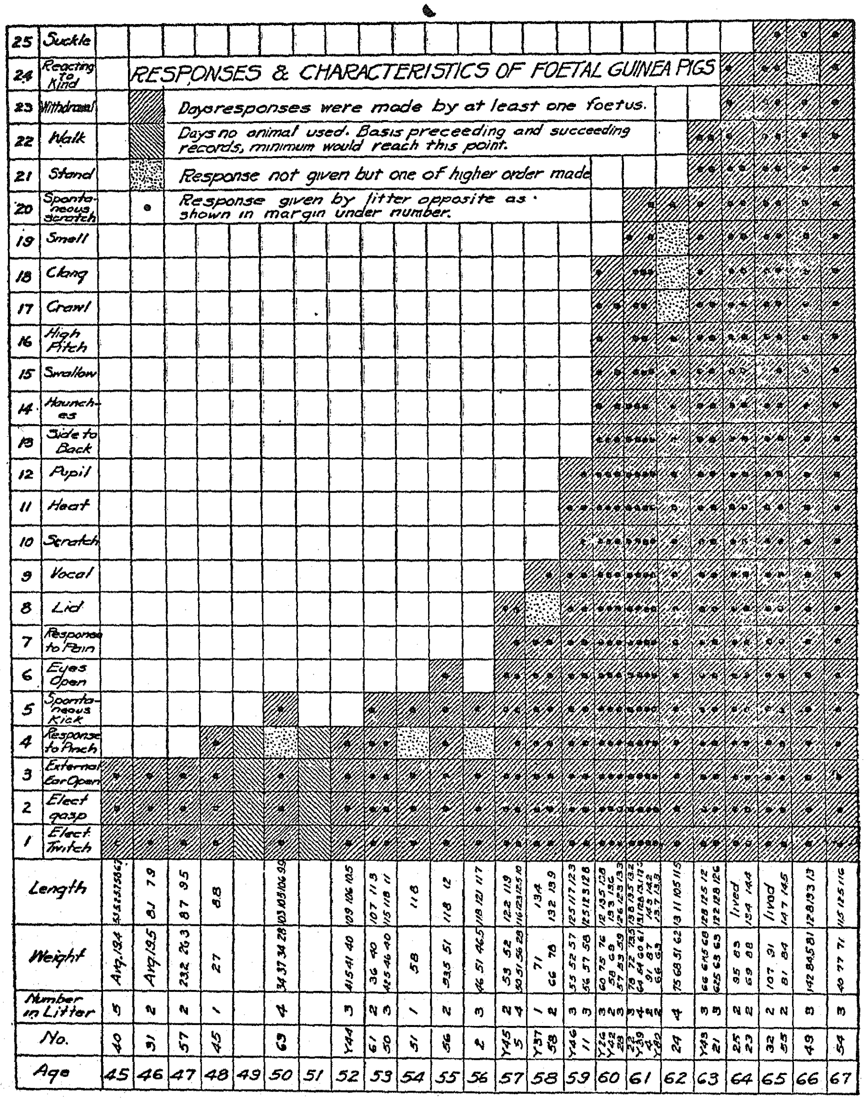


FIGURE 7

Responses and Characteristics of Fetal Guinea Pigs after the Forty-fifth Gestation Day

Age indicates length of gestation period. *No.* indicates mother's numerical designation; *Y*, young mother. Weight and length are given for each fetus. Responses and characteristics are numbered from bottom to top in genetic order of appearance.

(From G. T. Avery's (13) "Responses of Foetal Guinea Pigs Prematurely Delivered." *Genet. Psychol. Monog.*, 1928, **3**, 301.)

anisms exist in fetal and newborn guinea pigs. Some of these are subject to early modification through experience" (13, p. 329).

The present writer is now engaged in the study of certain aspects of the developmental behavior of the fetal guinea pig (52). The primary purpose of this study is the investigation of the changes in response which result from stimulation of specific receptor surfaces in successive fetuses at different age levels. In order to prepare the material for this study, pregnancy, at a known number of days subsequent to copulation, is intercepted. The mother animal is deeply etherized, an incision is made in the skin and muscles in the neck, and by means of a specially devised instrument the spinal cord is severed at the level of the fourth cervical vertebra. Immediately after this operation the ether is discontinued and an incision is made, while deep anaesthesia is still maintained, in the region of the umbilicus in such a way that slight subsequent operation will give access to the abdominal viscera. The animal is then allowed approximately two hours to recover from the ether, after which it is placed in an appropriate bath of physiological salt solution maintained at a constant temperature of 37.5° C. One by one the fetuses are then shelled out of the uterus and observed in a well-lighted bath so arranged that highly magnified motion pictures may be taken of the fetal behavior.[1a] Beginning with the completely immobile fetus approximately 25 days of age, different litters are studied, on each subsequent day, or in certain instances on parts of a day, during the entire gestation period up to the time of normal birth at 68 days. This investigation has not yet proceeded far enough to make possible a final report of the results, but it may be said that the protocols and motion-picture records so far taken show a general increase in the specificity of response to tactual and other stimuli in the periods before that at which Avery's records first begin. In Figure 8 the chart is shown which is used to direct the stimulation of each fetus so that the development of the "reflexogenous zones" may be made out in detail.

Coronios (90) is at present also working in the Brown University Laboratory of Psychology on the general descriptive study of the development of behavior in the guinea pig when placental circulation is maintained and when the fetuses are studied in a blood-warm aquatic environment. The technique of the present writer's study indicated above has indeed been in part devised by Coronios. This investigation is intended to supplement the data already given by Avery, but secured under the special environmental conditions noted above. In this work moving pictures are being taken to supplement written protocols. It should be noted in passing that such photographic records are peculiarly significant in preserving sequences of behavior which, because of the focus of attention, might be altogether lost otherwise. Such moving pictures have been used in a number of developmental studies such as those of Swenson (313), Angulo

[1a]The writer wishes to express his gratitude to the National Research Council for making the purchase of this recording film possible.

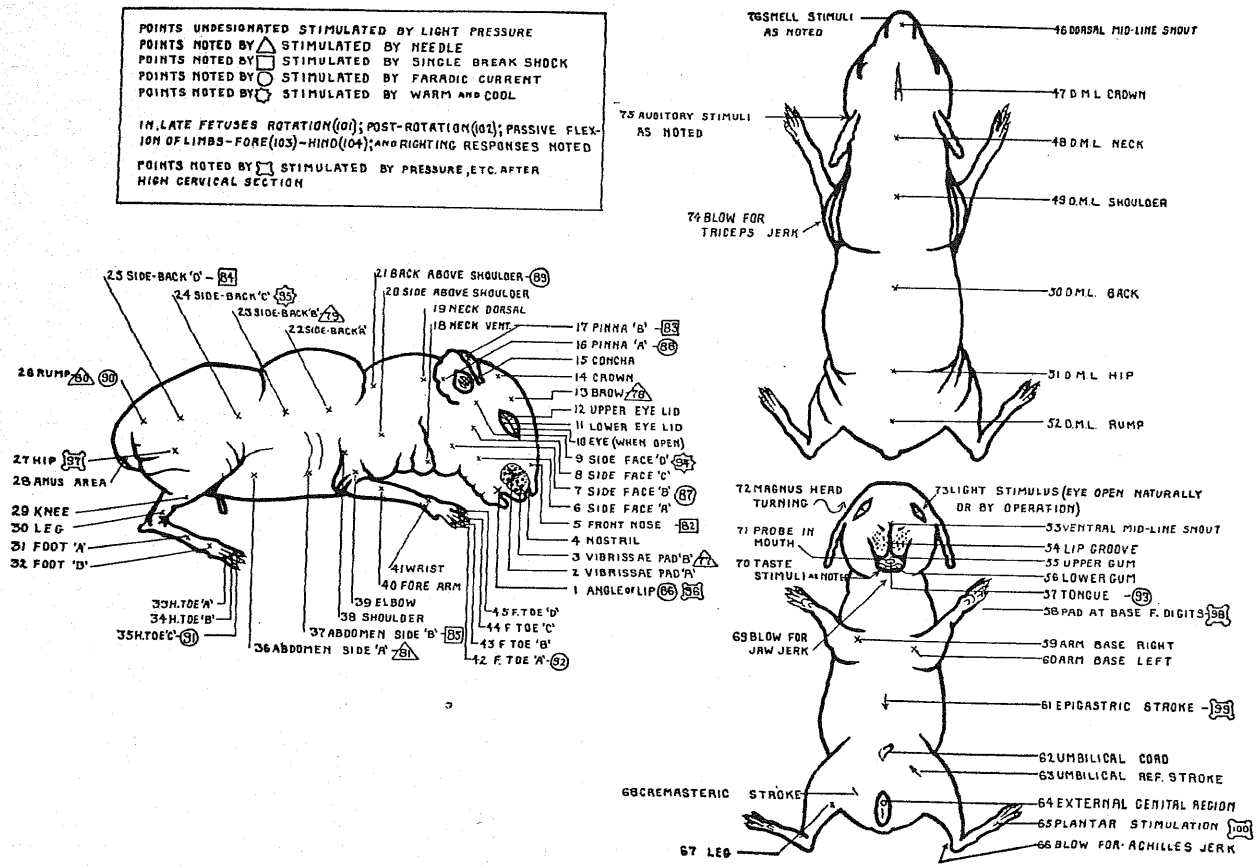


FIGURE 8

CHART USED IN STUDY OF DEVELOPMENT OF "REFLEXOGENOUS ZONES" OF THE FETAL GUINEA PIG

The points indicated suggest the form of stimulation and areas stimulated in a relatively mature fetus. In younger fetuses an abbreviated procedure is used.

(From L. Carmichael's (52) "The Development of Reflexogenous Zones in the Fetal Guinea Pig. Unpublished.)

y González (8), and Coronios, Schlosberg, and Carmichael (91). The detail of these studies on the prenatal development of the guinea pig makes it difficult to understand the diagram of "Behavioral Reaction" in the postnatal guinea pig taken from Tilney and reproduced by Woodworth (350, p. 207). Posture, sucking, crawling, eye-opening, eye-head turning, walking, and other acts are there shown as occurring after birth. Surely some of these acts should be considered as a "return engagement" after a fetal showing and not as "the first appearance on any stage."

Of all rodents, however, not the guinea pig, but the white rat seems to be considered the most generally available laboratory mammal. It is not surprising, therefore, that in recent years an increasing amount of attention has been given to the prenatal development of behavior in this convenient organism. One of the most elaborate studies of this sort is reported in an unpublished thesis by Swenson, done under the direction of Coghill, entitled "The Development of Movement of the Albino Rat before Birth" (311). The operation by which the female is rendered immobile is described by Swenson in a special article (310). The mother is deeply anaesthetized, the neck is opened, and the carotid arteries are ligated as close to their origin as possible. The large left and right external jugular veins are also secured and ligated. Ether is now discontinued and the skin incision is closed. After anaesthesia has been allowed to pass off, the mother is immersed in physiological salt solution. Each fetus is then in turn shelled out and studied.

Swenson's observation began with fetuses showing absolutely no movement save heart beat, and continued at convenient stages to birth. It is difficult to generalize about any such developmental sequence because the omission of any of the details of the onset of behavior is apt to give a prejudiced picture of the total process. It is possible in review here, however, to give a few of the salient points of the growth of behavior in the rat as found by Swenson. The first movement noticed was a slight lateral bending of the head. This same movement, differently interpreted, may be characterized as a slight cephalic trunk-bending movement. From this first action to the precise adaptive movements of tongue and paws in late fetuses, there is found a continuous quantitative and qualitative change in the movements observed in litters of increasing gestation age. Some of the facts observed by Swenson are summarized in Table 1.

This table, compiled by the present writer from Swenson's unsummarized protocols which may not in all respects be correctly interpreted, gives a generalized picture of the development of behavior in the fetal rat as determined by Swenson and by Angulo y González. Any such table, however, must be inadequate to suggest even a complete summary of development. The qualitative change which occurs may be made clearer by two excerpts describing responses to the same stimulus in different fetuses of different gestation age. Swenson writes of a fetus of 379 hours as follows: "Stimulated the snout with the bristle and a feeble and slow unilateral trunk contraction occurred." Stimulated again, "the response

TABLE 1

Table to Show the Onset of Special Acts of Behavior in the Fetal White Rat

This table is intended to summarize the observations of Angulo y González, signified by *A* in the table, and of Swenson, signified by *S*. The crown-rump and gestation-age relationships are taken from Stotsenberg as given by Needham (248, p. 1671).

Reactions	14 days 336-360 hrs. 9.5 mm.	15 days 360-383 hrs. 12.1 mm.	16 days 384-407 hrs. 13.0 mm.	17 days 408-431 hrs. 16.3 mm.	18 days 432-455 hrs. 19.1 mm.	19 days 456-479 hrs. 22.7 mm.	20 days 480-503 hrs. 22.7 mm.
1. Lateral flexion of the trunk		S A					
2. Lateral flexion of the trunk with movement of the forelimbs		S	A				
3. Lateral flexion of the rump		S?	A				
4. Extension of the head			S? A				
5. Extension of the head with opening of the mouth			S A				
6. Extension of the head with opening of the mouth and protrusion of the tongue			S A				
7. Lateral flexion of the rump with movement of the hind limbs		S?	A				
8. Ventroflexion of the trunk and rump			S A				
9. Independent movement of the forelimbs		S?	A?				
10. Maintained contractions			S A?				
11. Contraction of the abdominal muscles			S	A			
12. Extension of the rump			S	A			
13. *Flexion at the elbow and wrist associated with trunk movements*				S A			

TABLE 1 (*continued*)

Reactions	14 days 336-360 hrs. 9.5 mm.	15 days 360-383 hrs. 12.1 mm.	16 days 384-407 hrs. 13.0 mm.	17 days 408-431 hrs. 16.3 mm.	18 days 432-455 hrs. 19.1 mm.	19 days 456-479 hrs. 22.7 mm.	20 days 480-503 hrs. 22.7 mm.
14. Attempt to assume "the optimum physiological posture"				A	S		
15. Rotation of the trunk and rump				S A			
16. Independent movement of the hind limbs			S	A			
17. Extension of the head and rump with kicking of the hind limbs				A	S		
18. Independent opening of the mouth			S		A		
19. Independent extension of the hands					S A		
20. Independent flexion of the hands					S A		
21. Specific reflexes					A	S	
22. Movement of the tail		S?			A		
23. Flexion at the ankle			S		A		
24. Wrinkling of the skin			S		A		
25. Flexion at the hip			S		A		
26. Movement of the toes							
27. Independent movement of the feet			S			A	
28. Independent movement of the tongue			S		A?		
29. Wrinkling of the snout						S A	
30. Independent active closing of the mouth					S	A	

was a feeble lateral flexion of the trunk and a movement of the head to the side" (311). In speaking of a fetus a few gestation days older, however, one of 428 hours, in which the snout was again stimulated, the following account of behavior is given:

> "A complex movement with extreme maintained head extension and allied with more or less coordinated forelimb movement. The rump is in the meantime rotating laterally, the trunk flexing laterally with occasional and periodical vigorous ventral flexion and movements of the rump. The tail movement is closely associated with the rump movement. At times, the forelimbs, sometimes the left and other times the right forelimb, flex forward and dorsally, so that the paw is at the level of the ear. At times both right and left forelimbs do this at the same time. . . . The left forelimb and left hindlimb during a ventral flexion of the rump actually touch each other on the paws" (311, pp. 117 f.).

In the general theoretical discussion of the causal factors concerned in the development of behavior, we shall again refer to the work of Swenson, particularly to the observations which he made upon fetuses with clamped umbilical cords. Clamping of the cord he found to lead to an increase of metabolites in the fetal system and certain characteristic behavioral changes. Abstracts of the work noted above, and additional observations, have been published by Swenson (312, 314).

Angulo y González, also associated with Coghill, has recently published an even more elaborate study of the development of behavior in the fetal albino rat. He used virtually the same technique as Swenson in operating on the mother rat and in preparing the fetal material for observation. He has, however, selected his material with unusual care. Of the 643 fetuses used in his most recent study, all came from healthy female rats of known stock of 110 to 190 days of age, his previous work having indicated that these precautions were necessary in order to secure scientifically comparable results at various gestation ages. In his work moving-picture records were taken to supplement the written protocols. The conclusion of Angulo y González' work, subject to the same qualifications as those suggested above for Swenson, is, as indicated in the subscript to the table, shown in comparison with the results of Swenson in Table 1. It should be noted that this table records the earliest date on which specific movements were observed by each investigator. Angulo y González in his own experimental report gives the percentages of fetuses showing each movement at each age. For these detailed conclusions the reader is advised to consult the original papers.

It is interesting to note that both Swenson and Angulo y González first independently observed movement in the rat fetus in the 378th hour after insemination. Angulo y González' general description of the developmental process, particularly so far as the process of "individuation" of behavior is concerned, may best be given in his own words.

> "During the early stages of development the appendages move only

with the trunk. Thus, upon stimulation of the snout the reaction more frequently obtained is a total mass reaction which involves the trunk and appendages. This total mass reaction we called a total pattern. This total-pattern reaction consists of a primary or basic movement, lateral flexion of the trunk, and a series of secondary movements. Similarly, there develops later a total pattern consisting of a basic movement of head extension and a series of secondary movements. The basic movements, during the early period of behavioral development, assert their sovereignty upon the secondary movements. During the later period of the development of fetal behavior, we find a number of specific reflexes showing what at first seems to be a breaking up of the total patterns into individual and specific reflexes. But close study has convinced me that the process by means of which the individuation and specificity of certain reflexes is attained is not a disintegration or breaking up of the established pattern, but, rather, is due to an inhibitory action by means of which the primary or basic movements are in a large measure arrested. In other words, the total-pattern reaction is never abolished completely, nor is the dominance of the primary over the secondary movements lost" (11, p. 442).

Besides these studies of the whole developmental sequence in the rat there have been a number of investigations devoted to certain aspects of the growth of the activity of the response mechanism in the rat. Lane (193) has studied the development of the correlation between structure and function of the special senses in the white rat. His method of preparing fetal material consisted in killing the pregnant mother and studying the excised fetuses in a warm chamber. This method is open to the limitations pointed out in the evaluation of Avery's work given above. During the observation period the fetus was bathed in a warm physiological salt solution. Lane's observation on the development of the senses may be summarized as follows:

Touch. He found no evidence of this sense in 7½-mm. embryos, a stage generally agreed upon as immobile. Neurologically, at this stage he found both sensory and motor fibers developed. The sensory fibers, however, had not as yet reached the periphery. In 16-mm. embryos, that is, in approximately a seventeen–gestation-day–old organism, the tactual sense is reported as present on the flanks and snout, as evidenced by motor response to needle-pricks. Lane reports no response to stimulation with a sable brush at this time. This is contrary to the findings of all subsequent investigators and is probably a function of the special condition of the embryo. In 23- to 28-mm. embryos, that is, embryos of approximately 19 to 20 gestation days, he reports response to stimulation with a fine sable brush as well as with a needle-prick. The snout region is most sensitive, although stimulation about the shoulder, upper arm, hip, rump, and thighs also evokes motor responses. He reports that there is a noticeable increase in the number of vibrissae as well as a greater complexity in the neural fiber basket of the vibrissae follicle. In very late fetuses and newborn rats a still better development of the tactual sense is found, responses

being elicited by stimulation of any point on the entire body, including the tail. Pain as the result of needle stimulation is at this period shown by squeaks. The fibrillae baskets in the vibrissae follicles are now elongated cylinders from the base of which neural fibrils in comparatively large bundles are seen to emerge, distad to the base of the follicle itself. In later stages there is no particular advance noted in tactual sensitivity, although the snout region continues to be superior to the rest of the surface in sensitivity.

Equilibrium. In regard to this sense, this investigator finds in 7½-mm. embryos no behavioral trace whatsoever. Histologically, he reports the semicircular canals to be as yet undeveloped. In the 16-mm. embryo, Lane again found no experimental evidence of the sense of equilibrium, although the semicircular canals are now well developed. In 23- to 28-mm. embryos, Lane still finds no experimental evidence of a sense of equilibrium. Histologically, the differentiation of the cells of the cristae are at this time further advanced than in the previous stage, although the sensory and supporting elements are not yet distinguishable. Slight indications of central connection with the cerebrum are noted. In a 35-mm. fetus the sense of equilibrium was first noted, as seen in the righting responses of the organism. Structurally, the semicircular canals are now virtually complete. In the first day after birth, however, the righting responses were better developed, as were the histological and neural connections seen in the semicircular canals. In later stages there was manifested a greater perfection in the sense of equilibrium accompanying an increasing power of coordinated movement. Lane makes no reference to the part possibly played by neck proprioceptors or by other receptor fields in determining these righting responses, nor is any reference made to the analysis of postural reactions suggested by the school of Magnus, to which reference will be made below.

Smell. Lane reports no satisfactory method of smell stimulation in rat embryos from 7½ mm. to 28 mm. in length. Histologically, he says, "During these stages the olfactory apparatus is being gradually laid down, both as regards its sensory and peripheral portions. The histological differentiation of the olfactory epithelium has not advanced sufficiently far to enable the sensory cells proper to be identified" (193, p. 51). Using a brush placed in an odoriferous substance, no certain response to olfactory stimuli was obtained in 35-mm. fetuses. Histological development, however, is noted as continuing. Small's work (297) on smell in the newborn rat is quoted, and the statement made by Lane that "there is on the whole a gradual perfecting of the olfactory sense from day to day" (193, p. 52). No experimental proof is given of this statement, and it is hard to understand in view of the difficulty reported in dealing with this sense in the white rat by Liggett (211).

Taste. In this sense, Lane reports that the 35-mm. fetuses were able to swallow, but neither in these nor in those of any preceding stage were any true evidences of a sense of taste discovered. At no time previous to

birth could taste buds or other fully differentiated organs of taste be demonstrated. The first day after birth, however, he notes that sugar solutions were received with less objection than salt or acid solutions. Lane again makes a generalized statement that in postnatal life this sense is gradually perfected, although no experimental evidence is given to support the view.

Hearing. Here Lane reports that "absolutely no response to sound was noted before the twelfth day after birth," and that "from that day to the sixteenth or seventeenth day there is a gradual increase in the ability to perceive sound" (193, p. 63). No evidence is given for this conclusion in the monograph, however, save that change is inferred from structure. In his conclusions, he says:

> "Previous to the twelfth day the portions of the ear concerned with the perception of sound have been undergoing a gradual development, but have not yet reached that degree of differentiation of the organ of Corti necessary for the perception of sound. By the twelfth or thirteenth day the organ of Corti is apparently differentiated for at least part of its extent, though the lumen of the external auditory meatus is not fully opened. The next few days witness the completion of the differentiation of the apparatus of hearing" (193, p. 63).

Vision. So far as this sense is concerned the report of Lane is: "Absolutely no response to light was obtained before the opening of the eyes on the sixteenth or seventeenth postnatal day" (193, p. 69). This was determined by the use of an electric flashlight. The objection may be raised, on the basis of a good deal of other experimental work, that this stimulus was possibly not strong enough to bring about response. No record is given of the pupillary response which might have been secured had the eyelids been opened by operation. Histological evidence, however, is given to suggest that there is a neural and receptor development paralleling the reported functional development.

The theoretical conclusions of Lane concerning the anatomical basis of early development in the rat fetus and concerning the function of the receptor in the development of the reflex arc will be given at the close of the present chapter.

From the report just given of Lane's work, as well as from the incidental observations in the work of Swenson and Angulo y González, it becomes obvious that, of all the sensory fields in the white rat, that of skin sensitivity is apparently earliest and most completely developed during prenatal life. The development of this sense in the fetal rat has been quite extensively investigated by Raney (280), working in the Psychological Laboratory at Brown University. In Raney's work the pregnant female is deeply anaesthetized and the spinal cord completely transected between the sixth and seventh cervical vertebrae. The result of this operation is to provide an effectively demobilized and, so far as the field of the operation is concerned, a completely desensitized adult organism in which, however, circulation and respiration continue in a virtually

normal condition. After a period of one and a half to two hours the fetuses are shelled out, with placental circulation maintained, into physiological salt solution held at 37.5° C. by thermostatic control. Raney's work was conducted not only in an effort to study the effect of change of skin sensitivity at various fetal developmental ages, but also to consider the origin of what may be called local sign, at least in so far as local signature may be demonstrated in the progress of localizing movements of the limbs of the fetus resulting from point stimulation. Klemm (183), in his history of space perception, has referred to the development of the view that space is perceived in relation to body movement. James also has considered the factors leading to this view (170, pp. 170-282), and more recently Peterson's experimental work on local signs as orientation tendencies has again emphasized this conception (270). Raney's work shows that with increasing gestation age the fetus first becomes sensitive to areal stimulation, that is, to stimulation with a camel's-hair brush approximately 5 mm. in diameter. Response to punctiform stimulation by a single light hair is observed to begin sometime later. The first appearance of sensitivity is in the head region, and this is observed to pass gradually caudad. The first responses to stimulation are slight movements of the trunk occurring during the sixteenth day, as noted by previous investigators. As development continues, stimulation at any sensitive point may elicit much more complicated behavior, often involving neck, trunk, forelimb, hind limb, and other muscle movements. The peculiar sensitivity to tactual stimulation of the region from which the vibrissae issue is noted throughout this developmental sequence. The early function of this tactual organ, as it may be called, is particularly interesting in reference to the full innervation of this area as shown by Lane and in the behavioral observations on the function of the vibrissae in young rats by Small (297), and especially in the special study of this receptor field by Vincent (323).

Raney finds, however, where the mechanical possibility of movement is present, that is, where the limb may touch the surface, that the responses may gradually become more and more precisely related to the point of stimulation. Thus at an early gestation age stimulation of the region of the vibrissae may lead to slight trunk movements. Later such stimulation may lead to very general movement of many muscle groups of the fetus, including the limbs. At a still later time, the principal movement may be that of the forepaw moved toward the point stimulated. If the point touched is on the body wall, the movement may be toward that point. If it is on the nose it may be toward that point. It must be noted, however, that, even at the most perfect period of such differentiated response in late gestation periods, the stimulation of any point may also bring out very general activity. It is possible that such generalized response is due to interruption of some "spontaneous" movement, or that it is related to the strength of stimulation, or the frequency of stimulation, or the immediate past activity of the organism. This is not the place for a full consideration of the theoretical implications of Raney's study, or of the re-

lated one referred to above that the present writer is carrying out on guinea pigs. It may be remarked in passing, however, concerning the bearing of these studies on the psychological theories of space perception, that the results suggest a certain reformulation of one form of the genetic theory of the perception of extension considered by Boring (32, pp. 250-262).

Lincoln (214), also working in the Psychological Laboratory at Brown, has been able to show in the rat fetus something of the elaborate sensory and behavioral sequence which is antecedent to the sucking reflex that is seen in the rat at birth. The report of this investigation has not as yet been published. This work is especially interesting in relation to Lane's work on the correlation between structure and function in the nursing reflex of the young rat and guinea pig. In Lane's work (194) especial attention is given to the development of the tongue both as a locus of taste receptors and as a prehensile organ. Further references to the sucking reflex are given below.

Besides the special studies noted above, there have been a number of other investigations dealing with particular muscle groups or special behavioral characteristics of the white-rat fetus. Corey (86) has studied the causative factors of the initial inspiration of mammalian fetuses using the white rat as material. In this study it is concluded that the initial respiration of the fetus is normally brought about by a change in the relationship between carbon dioxide and oxygen in the blood in cooperation with the stimulating effect of the drying of the skin. Blincoe (25, 26) has worked on the development of behavior in the motor system of the forelimb of the rat. He has elaborately studied the anatomy of the limb before the fifteenth day, that is, just before the onset of motility. An effort has also been made to present a correlation between this stage of development in the rat and in man. In a later study he points out that it seems that the arm of the rat shows the delicate assembling of many bodily components which await some complementary addition to render them a dynamic whole. It is suggested that this addition is to be found in functional innervation.

Bors (33), Nicholas (250, 251, 253), Hooker and Nicholas (156, 157, 254), and others have performed experimental operations on rat fetuses. Following a very elaborate technique, these students have been able to operate on mammalian fetuses without interrupting pregnancy. In the course of this work they have made a number of incidental observations on the development of motility, and they particularly point out the fact that during intra-uterine existence "movements are restricted to a large degree, and there is also a greater degree of independence of the individual cord segments than is found in the later post-natal stages" (157, p. 431). These observations are significant, for they are made under conditions more nearly approaching the normal conditions of development than any other studies on the development of mammals. These students are apparently the only ones who have systematically observed the same mammalian fetus in successive developmental stages.

A number of studies of special aspects of the development of behavior have been made on the rabbit, to a few of which reference has been made above. Preyer makes some observations on fetal organisms of this type (277, pp. 418 f.). Langworthy (198) has worked on progression in very young rabbits. He points out that in such animals decerebration does not lead to extensor rigidity, but to prolonged progression movements. In the more mature newborn guinea pig, however, rigidity follows decerebration. This difference is attributed to the degree of myelinization in the central nervous system. Zuntz (354) also used the rabbit fetus in his work on respiration. Richter (282) has observed sucking movements in rabbit fetuses about twenty days old. Pankratz (256) has adapted Swenson's technique to the study of the rabbit. Mechanical stimulation of nose, head, and neck led to response of simple lateral flexion of neck and trunk in fifteen- to sixteen-day rabbit fetuses. In a seventeen-day fetus there was a marked ventrolateral flexion of head and upper trunk, with some movement of the forelimbs. In twenty-day-old fetuses opening and closing of mouth, active movements of the forelimbs, flexion of the hind limbs, and lateral flexion of the whole trunk were observed. As the gestation period advanced the movements became more complex.

The cat has proved itself to be an eminently suitable animal for the laboratory study of the development of fetal behavior. Its neuromuscular system is quite highly organized. Its gestation age of over sixty days produces an organism at birth that is relatively mature. Much is known as a result of past research concerning its structural development (149, 206, 207), anatomy, and certain of its adult behavioral characteristics, such as the righting response (43). These factors combine to make the animal peculiarly available for research in fetal behavior. The general purposes of this chapter will best be advanced, it seems, by a relatively complete review of two recent and elaborate investigations of fetal behavior in the cat. Following the presentation of these two studies a discussion of several special investigations on particular forms of fetal behavior in the cat will also be given.

Windle and Griffin (346) have recently reported a study in which a large number of cat fetuses of known and unknown gestation age were experimentally studied. The technique employed by these investigators involved an operation on the brain of the mother cat such that later, without anaesthesia, it was possible for them to study the fetal organisms under warm physiological salt solution with fully maintained placental circulation. The methods of studying the fetuses varied more or less according to age. In all, thirty-four pregnant cats were used, giving one hundred twenty-five living embryos and fetuses for study. Of the thirty-four cats thus employed, nineteen of the litters were of known age since copulation. The ages of the other fetuses were calculated from their body measurements, a procedure that is not in all respects satisfactory.

These investigators report that no movement was seen in the twenty-three–day stage or in any day previous to that. In the twenty-four– and

twenty-five–day stage, what the reader may now begin to consider as the characteristic response of young fetuses, namely, the very slightest slow ventral lateral head flexion, was observed in a number of embryos. This has also been independently confirmed by Windle (341). In the twenty-six– to twenty-seven–day stage, movements were in general more complex and of greater amplitude or duration and strength than those noted in the previous case. Generalized trunk undulations, however, still formed the permanent background of activity, but forelimb flexion had also begun. The investigators point out that at this stage rotation of head and trunk appeared to be coordinated with older components, but that this activity results in movements which strikingly resemble the righting reflexes seen in later fetal life. At this stage the fetuses seemed unresponsive to brush or probe. At twenty-eight days slight flexion of the hind legs was noticed and at this time also the first responses to touch, particularly in the head region, were observed. Stimulation of this sort was followed by typical, apparently "random" head-trunk-limb undulations. At thirty days the activity recorded is still more complex. Active flexion of the hind limbs was noted, and at the same time definite, although sluggish, mouth movements appeared. From this time until birth, continued and progressive increase in the specificity of behavior was noted by these observers. A summary of this work is given in Table 2, which is taken directly from the report of these investigators.

So far as the development of sensory capacity in these animals is concerned, it has already been noted that no external response to stimulation is found in fetuses of less than 26 mm., that is, of approximately twenty-eight gestation days. These investigators hold that there is evidence, however, of exteroceptive and proprioceptive function even in the first animals that show spontaneous movements. "The fact that the unilateral trunk or neck flexions seemed always to be executed toward the observer and away from the surface on which they rested may indicate that the earliest sensation is one of deep pressure" (346, p. 175). So far as the behavior of the 26-mm. stage is concerned, it is held that the activity noted may be the result of a "primitive type of proprioception." This would explain the spread of motor response, although there is some possibility that the wave-like progression of muscular contraction noted is due to the function of long association pathways in the central nervous system.

The first so-called "cutaneous reflexogenous zone," that is, cutaneous area, in which stimulation can be shown to lead to response, included the nose areas and in general most of the head. Pronounced response in the fetuses at twenty-eight days followed stimulation of the nose. Gradually, as fetuses of older ages were considered, the area spread caudally to the neck, pectoral region, forelimbs, trunk, hind limbs, and, finally, to the tail. They point out that "it is interesting to note that spontaneous motor activity always involved a part of the body before response could be elicited in it either locally or at a distance from the point stimulated" (346, p. 175). The strength of stimulation was also reported as significant in determining

TABLE 2

SUMMARY OF MOTOR RESPONSES OF CAT EMBRYOS AND FETUSES REPORTED BY WINDLE AND GRIFFIN (346)

		Neck and trunk										Fore limb						Hind limb						Intrinsic head muscles			
Copulation age of specimens	Length of specimens (C.R. in mm.)	Unilateral flexion of head and upper trunk	Ventral flexion of head and upper trunk	Bilateral flexion of head and upper trunk	Rotation of head	Flexion (ventral) of lower trunk	Rotation of trunk	Flexion of tail	Abdominal muscles	Intercostal muscles	Diaphragm	"Passive" flexion at shoulder	Active flexion at shoulder (total flexion)	Flexion at elbow	Flexion at wrist	Adduction of limb	Flexion of digits	Movement of pelvis (trunk)	Flexion at hip	Flexion at the knee	Flexion at the ankle	Adduction of limb	Flexion of digits	Masticator muscles	Tongue muscles	Facial muscles	Laryngeal muscles (phonation)
23	14	−																									
24+	16	+		−								−															
24.5	17	+		−	−							+	−														
?	17.5	? +	?	−	?	−						+	−														
?	18.5	+	+	+	+	−						+	?	−													
25	19.5-20	+	+	+	+	+	−					+	+	−													
26	21-22	+	+	+	+	+	+	−				+	+	+	?	−		+	−								
27	22.5	+	+	+	+	+	+	−				+	+	+	−	−		+	−								
28	26	+	+	+	+	+	+	−				+	+	+	−	−		+	+	−							
30	27-28	+	+	+	+	+	+	−				+	+	+	+	−		+	+	−				+	−		
31	36	+	+	+	+	+	+	±	±	±	−	+	+	+	±	?	−	+	+	±	−			+	?	−	
33	38	+	+	+	+	+	+	+	?	?	−	+	+	+	+	+	−	+	+	+	−			+	−	−	
35	45	+	+	+	+	+	+	+	?	?	−		+	+	+	+	−	+	+	+	−			+	±	−	
36	50	+	+	+	+	+	+	+	+	+	−		+	+	+	+	?	+	+	+	?	−		+	+	±	−
?	50-54	+	+	+	+	+	+	+	+	+	?		+	+	+	+	−	+	+	+	?	−		+	+	−	−
?	58-60	+	+	+	+	+	+	+	+	+	?		+	+	+	+	?	+	+	+	+	?	−	+		−	
42	75-80	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	?	?	+	±	−	
?	95-103	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
?	110	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
?	135-140	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

the nature of response. Usually the light touch of a brush was found to be ineffective in specimens less than 60 mm. long. In the case of a few fetuses a little longer than this a response was secured when the brush was applied to the nose. It was noticed that a light stimulus which caused no response if once applied was sometimes adequate if repeated several times. Very little difference could be observed between strong innocuous stimulation and stimulation producing observable protoplasmic damage. The authors believe that the primitive type of pressure-touch sensation, which they postulate on the basis of their observations as the characteristic receptor surface of early fetuses, was not replaced by definite touch and pain until relatively late in fetal life. In fetuses of 75 to 80 mm., marked differences between the responses to light and strong stimuli were observed, and pain responses were thought to be definitely present.

Vestibular functions probably appear in prenatal life, these investigators, who are especially well trained to consider this sense, report, although no absolute evidence of its presence is found until very shortly before birth. It should be borne in mind in all considerations of this sense in fetal life that there are great difficulties in testing it accurately in a squirming fetus. In a later study Windle and Fish (345), however, have been able to demonstrate by the use of several techniques including the operative interference with the vestibular apparatus that the true vestibular righting reflex probably appears in fetal kittens of 100- to 115-mm. crown-rump length, that is, on the fifty-fourth day of gestation. These same investigators (120) have considered the onset of rotary and post-rotary nystagmus in the eyes of newborn cats.

From study of the vestibular sense Windle and Griffin turn to a consideration of the development of posture and progression in general. In this study they follow in part the analysis of Hinsey, Ranson, and McNattin (150). Walking can be shown to require the coordination of several behavioral patterns including the ability to maintain an erect posture. In this connection the analysis of Magnus which shows that posture may depend on impulses from the various receptor groups of the non-auditory labyrinth, from the proprioceptors of the muscles and associated structures, and from the exteroceptors including touch and the distance receptors, is distinctly relevant (220, pp. 357 f.). In view of the facts it becomes obvious that the maintenance of erect posture may demand quite elaborate stimulation and the establishment of postural tonus by the proper neurological balance between flexor and extensor muscle groups. This complex mechanism makes possible successful opposition to gravity and behavioral acts dependent upon such opposition. For an illuminating evaluation of the effect of gravity on the development of behavior in mammals, the reader should consult the recent treatment of this subject by Holt (153, pp. 62-72). Windle and Griffin further show that the essential receptor and effector mechanisms necessary for progression involve an added condition, by means of which alternate and rhythmic changes in the limbs are brought about. This last component

is necessary if balance is to be changed in such a way that stepping movements may be accomplished.

Windle and Griffin report that these essential mechanisms to locomotion develop at different times in the fetal cat. The onset of the righting reflex has just been reviewed. The first positive evidence of rhythmic movement of the forelimbs, involving flexion and extension movements, was seen in a 58- to 60-mm. fetus. At this time the hind-leg movements were less rhythmical. Occasionally in a 100-mm. fetus complete stepping movements were observed. In this connection the study of Laughton (208) on the nervous mechanism of progression in mammals should also be consulted. It is further suggested by Windle and his associates that the unilateral rhythmic flexion-extension of the limb as seen in the scratching reflex may have a relationship to the occurrence of the alternate rhythms of locomotion. The first indication of the scratch phenomenon was thought to have been observed at 75 to 80 mm., following ear stimulation. These observations show that the analysis of walking in prenatal life involves a complex series of factors concerned with virtually the entire receptive field and the entire muscular system of the organism.

Besides this characteristic behavior pattern, these same investigators have also studied the development of the sucking reaction, a response which, like that of locomotion, is characteristic of early vertebrate behavior and to which reference has been made above. The first head-raising and lowering of the jaw was noted in 27- to 28-mm. fetuses. This early pre-feeding response was followed in the 45- to 50-mm. organisms by tongue reflexes, which were so amplified in the 70- to 80-mm. organisms as possibly to be characterized as sucking. In the 95- to 103-mm. organisms, this response had so much further developed that it was present in virtually its adult form (346). The theoretical conclusions of Windle and of Windle and Griffin in regard to certain of the causal factors in the development of behavior will be considered at a later point in this paper.

Another elaborate study of the development of behavior in the fetal cat was undertaken in 1928 by Coronios, working in the Brown University Psychological Laboratory (87-89). Unlike Windle and Griffin, Coronios used only fetuses from litters whose copulation age he accurately knew. In Coronios' work the pregnant female was prepared for the observation table by administering deep ether anaesthesia, after which the carotid arteries were ligated, a cannula inserted in the trachea, and a complete midbrain section carefully performed. After this section, the anaesthetic was immediately discontinued and the decerebrate adult cat allowed to remain quiet for from an hour and a half to two hours before the fetuses were exposed for observation by an operative technique. Before the observations began, the cat was placed in a specially devised bath apparatus in which physiological salt solution was maintained thermostatically at $37.5° \pm 0.5°$ C. Into this blood-warm liquid the fetuses were one by one shelled out. A summary of the behavior observed at various copulation ages may be found in Figures 9 and 10. In supplement to these charts Coronios offers the following conclusions:

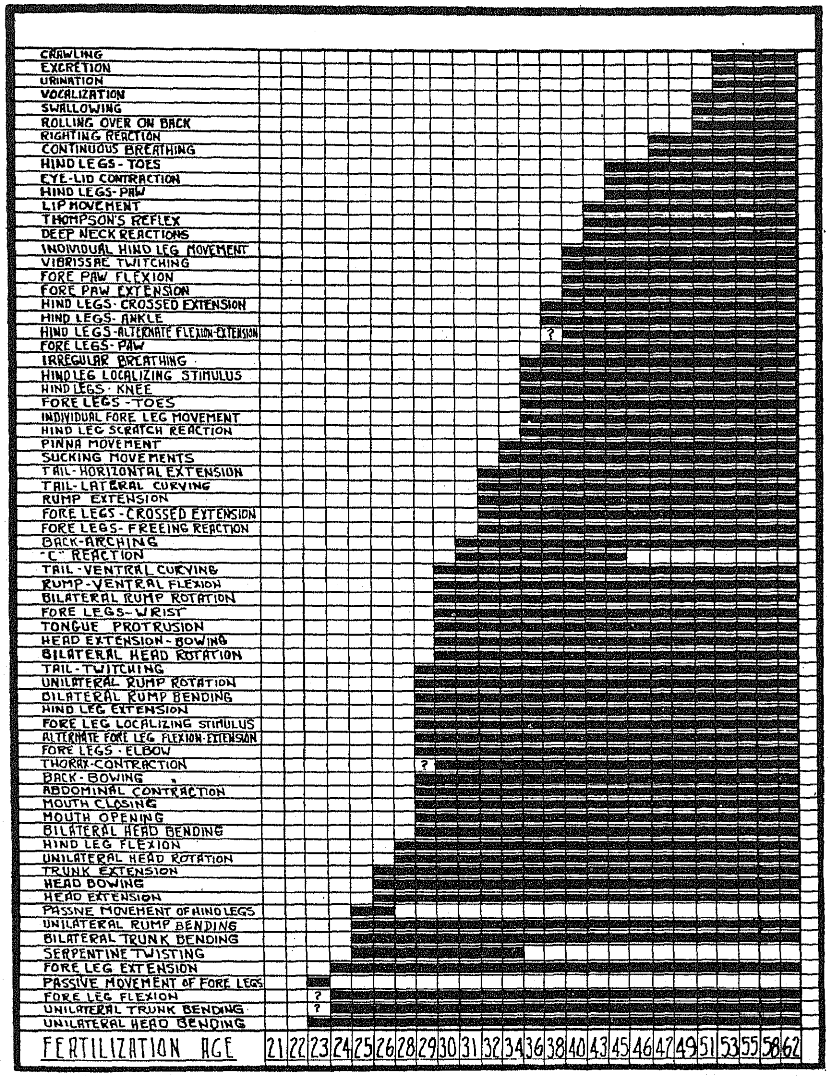


FIGURE 9

A CHART CONSTRUCTED TO SHOW THE DEVELOPMENT OF BEHAVIOR IN CAT FETUSES OF VARIOUS GESTATION AGES

(From J. D. Coronios' (89) "The Development of Behavior in the Fetal Cat." To be published in *Genet. Psychol. Monog.*)

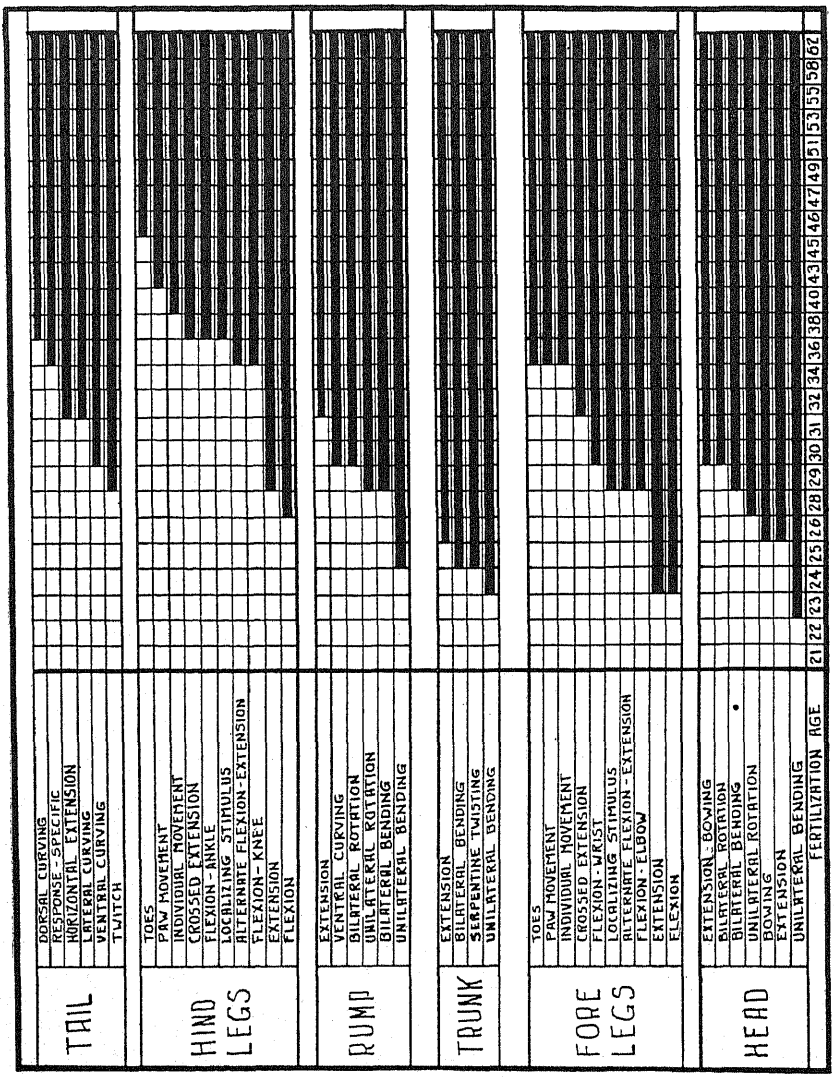


FIGURE 10

A Chart to Show the Development of Behavior in Cat Fetuses of Various Ages, Cephalocaudal Development, and the Individuation of Behavior in Special Body Areas

(From J. D. Coronios' (89) "Development of Behavior in the Fetal Cat." To be published in *Genet. Psychol. Monog.*)

"In the early stages the behavior is diffuse, variable, relatively uncoordinated and weak. With the increase in gestation age the reactions become more vigorous, more regular in their appearance, less variable, individualized and better coordinated. These qualitative changes do not occur abruptly but are continuously progressive modifications in the quality of the observed reactions. Moreover, these qualitative changes do not, as it were, 'invade' the total organism at once. Rather they seem to follow a general course in their development beginning at the head region and progressing toward the tail" (89).

It is interesting to note in this description of the development of behavior in a highly organized mammalian fetus a marked similarity with the description of the development of behavior noted in Amblystoma and virtually all other forms considered above. It must be emphasized, however, that there is danger in making generalizations too sweeping in regard to fetal behavior, but it is impossible to deny that there are certain descriptive forms which accurately characterize the development of behavior in many forms.

As a final conclusion of his work, Coronios (89) makes the following five points:

"1. Before birth there is rapid, progressive, and continuous development of behavior in the fetus of the cat.
2. The development of behavior progresses from a diffuse, massive, variable, relatively uncoordinated state to a condition when many of the reactions are more regular in their appearance, less variable, better coordinated, and relatively individualized.
3. In the early stages of prenatal development the behavior appears to be progressing along a cephalocaudal course.
4. Behavior development appears first in the gross musculature and in the fine musculature later.
5. Behavior develops in each of the limbs from a proximal to a distal point; that is, the entire limb is first involved in the response and then gradually the more distal joints become, as it were, independent of the total movement."

Each of these generalizations is to be taken as a statement of a typical course of development and not as a specific formula that can be applied in advance of observation. From the time of Aristotle the anterio-posterior course of development has been noted (248, p. 75). This apparently holds true in the primitive gradients of the organism and, indeed, in the weight of its developing structure and in the development of "individuated" behavior. This generalization must, of course, be considered as descriptive and not explanatory. For further discussion see Kingsbury (181, 182) and Child (56).

Besides these two elaborate studies of the development of behavior in the fetal cat, there have been a number of incidental studies calculated to investigate some special problem in fetal behavioral growth. Brown (38, 39) reports an experiment on the development of the mechanism of pro-

gression in the fetal cat. He used four fetuses of unknown gestation age, the placental circulation, however, being maintained and the observations made in a warm salt solution. The fetuses were studied both before and after decerebration. On the basis of this work he asserts that blood stimulation is very important in eliciting the rhythmic movements seen before birth. He concludes, "It is possible that the 'quickening' movements which are a symptom of human pregnancy may be due to similar progression movements in man; and if they are thus evoked by some such accidental asphyxia as that conditioned by pressure upon the umbilical cord they may tend, in an indiscriminate manner it is true, to relieve that pressure." He also suggests on the basis of other observations a phylogenetic theory of the development of locomotion based on Sherrington's view of motor half-centers in the central nervous system.

Langworthy (201) has also studied the development of behavior in the fetus of the cat. In 1929 he reported a study on six fetuses near term and a number of kittens of varying ages after natural birth. In these fetuses, after decerebration, he found behavior that is characteristic of the late cat fetus, although less well-defined hind-leg movements were observed than those reported by Brown. The behavior of the fetal and young organisms was then correlated with structural studies of the nervous system. He reports in summary of this work that "bilateral movements of the extremities begin to coordinate when the ventral commissural fibers of the cord receive their myelin sheath. The animals turn the body at a time when myelinated vestibular fibers reach the spinal cord. The hind-leg movements become better coordinated when myelinization becomes marked in the lumbar portion of the cord" (201, p. 169). The general significance of this correlation of behavior and myelinization will be considered below. Tilney has prepared a chart showing the stream of behavior reaction in the cat similar to the chart concerning the development of behavior in the guinea pig cited above (350, p. 204). In this chart many behavioral acts are shown as appearing in postnatal life which the studies given above show in prenatal life. This is true of "primitive escape," "scratching," and, indeed, basically all of the reactions shown in the chart. The "sudden emergence" of some of these behavior patterns noted below the chart as in most "saltatory maturation" may seem therefore to involve the reactivation under different environmental conditions of behavior which has had a prenatal developmental history. Similar facts in regard to human fetal development are significant in interpreting the conclusions of Gesell (126) and Shirley (294, 295) concerning human behavioral maturation.

A number of special studies have been made on other mammals. Erasmus Darwin quotes an account from Galen concerning the fetal development of the goat. The fetus, after removal, got upon its feet and walked, shook itself, scratched, smelled of objects, and then drank milk (98, p. 196). Huggett has recently used this same ungulate in elaborate studies of the onset of breathing reflexes in the fetus which will be considered below (159). He used animals one or two months before full term. The

size of the animal made it convenient for operative purposes, but a "domestic bath" had to be used to hold the saline solution into which the fetus was delivered (158).

Bolk (30) has made a comparative morphological study of fetuses of the gorilla, chimpanzee, and man in relation to a theory of development. Tinklepaugh, Hartman, and Squier (320) have studied fetal heart rate in the monkey.

Incidental observation on other animal fetuses are given by Craig (93) in his revision of Fleming's *Veterinary Obstetrics*. Needham gives tables of the gestation times of hundreds of animals, which are valuable for comparative purposes (248, pp. 484-489).

V. General Aspects of Human Fetal Development

From one point of view at any rate, all that has gone before in this paper has been intended to prepare the reader for the consideration of prenatal development of behavior and an application of this knowledge to human psychology. Behavioral development before birth has long been the subject of notice in the human race, but only comparatively recently has it been studied in a systematic scientific manner.

It is probable that the fact that the fetus moves before birth is knowledge that is as old as mankind. Certainly there are references to this phenomenon in the folklore of primitive peoples (273). It is interesting to notice also, so far as the anthropomorphic theory of primitive deities is concerned, that the process of making gods in the image of men even included speculations in regard to god embryos. For a consideration of this topic, see Briffault's work, *The Mothers* (36), and Witkowski (349). There are references to prenatal development of behavior in Biblical literature and in ancient Indian and Chinese writings. The Egyptians early began the consideration of this matter, as is shown in a hymn to the sun-god attributed to Amenophis IV (about 1400 B.C.):

> "Creator of the germ in woman,
> Maker of seed in man,
> Giving life to the son in the body of his mother,
> Soothing him that he may not weep,
> Nurse (even) in the womb.
> Giver of birth to animate every one that he maketh
> When he came forth from the womb on the day of his birth"
> (248, p. 49).[2]

In pre-Socratic Greek antiquity among the many who speculated on almost all aspects of nature there were those who considered embryology

[2]For much of the historical material given at various parts of this paper, including the quotation at the head of the chapter, the present writer is indebted for actual references and for many interpretations to Needham's illuminating history of embryology. The present writer had begun the collection of material in this field before Needham's book was published, but when it appeared it proved to be so fruitful in suggestion that it has been extensively used in this paper. Whenever possible, specific references are given.

and, apparently, also the beginnings of fetal activity. It was at this time, the very beginning of recorded scientific history, that some of the notions arose which have come down to our own period in what has been called "theological embryology." At this time some held that the general form of the body is completed in males many days before it is completed in females (248, pp. 51-53). Similarly, Empedocles (about 450 B.C.) began the speculation, which was long to continue, as to whether or not the "life" of the embryo was like the "life" of the independent individual (248, p. 51). Plutarch says that Plato directly asserts that the fetus is a living creature that moves and is fed within the body cavities of the mother (ca. 429 B.C. to 347 B.C.) (248, p. 60). It was not, however, until the time of Aristotle (384-322 B.C.) that the life and soul of the embryo were considered in detail. In chapter three of Aristotle's remarkable treatise on embryology, the entrance of the various souls into the embryo is considered. The views there expressed have possibly influenced the laws in regard to abortion which have appeared since Aristotle's time in canon and civil codes. In transmuted form these ideas appear in both patristic and scholastic philosophy. It is possible that this Aristotelian doctrine is basic to the rules of the church in regard to prenatal baptism which is considered historically by Witkowski (349, pp. 133-152). Aristotle taught that the vegetative or nutritive soul existed in the unfertilized material of the embryo. In summary, Aristotle, in the following quotation given in Needham's version, says:

> "For nobody would put down the unfertilised embryo as soulless or in every sense bereft of life (since both the semen and the embryo of an animal have every bit as much life as a plant). . . . As it develops it also acquires the sensitive soul in virtue of which an animal is an animal. . . . For first of all such embryos seem to live the life of a plant, and it is clear that we must be guided by this in speaking of the sensitive and rational soul. For all three kinds of soul, not only the nutritive, must be possessed potentially before they are possessed actually" (248, p. 69).

During the third century B.C., Herophilus, according to Plutarch, attributes to newborn babies a natural movement, but not respiration. The sinews are the instrumental cause of this movement. Afterwards the baby becomes a perfect living animal and when it is taken forth from the mother's body it inhales air (248, pp. 78-80).

Between 150 and 180 A.D., Galen is also credited with writing much upon the question of developmental embryology. He has especially considered the question of whether the embryo must be considered to be an animal. A reference to Galen's observation on a goat fetus has already been considered (98).

In the patristic period interest continued in the movements of the fetus. Tertullian (born 160 A.D.) held that the soul was fully present in the embryo through uterine life. In his *De Anima* he says:

> "Reply, O ye Mothers, and say whether you do not feel the movements of the child within you. How then can it have no soul?" (248, p. 91).

St. Augustine, Bishop of Hippo, apparently did not wholly agree with this, but held that the soul entered the fetus in the second month and sex in the fourth gestation month. Other church authorities followed St. Augustine in this matter. The council of the church held at Byzantium in 692, however, declared that no distinction could be made so far as infanticide is concerned as to whether the fetus was "formed" or "unformed." Canon law finally came to recognize the fortieth day for males and the eightieth day for females as the moment of animation, but later the fortieth day was accepted for both sexes (129, p. 5). For a modern view of sex differences in development as an exercise in contrasts it may be interesting to consider the work of Riddle (283).

In the Talmudic writings of the learned Jews between the second and sixth century are found a number of views of the development of fetal behavior in regard to the possibility of stimulating the fetus in the uterus. There is a quotation that may possibly imply that the cutaneous sensitivity of the fetus was understood by these writers (248, p. 93). Needham gives a reproduction of a picture from the *Liber Scivias* of St. Hildegard of Bingen of approximately 1150 A.D., which shows a pictorial representation of the soul passing down from heaven and entering the body of a pregnant woman and then entering the embryo (248, p. 96). It is not difficult to believe that the basis for this picture is to be found not only in such embryological knowledge as had come down to this time from antiquity, but also in the direct observations current in all times concerning the quickening of the embryo. Albertus Magnus (1206-1280) referred in his writings to the quickening of the embryo (248, p. 102). The greatest of the schoolmen, however, St. Thomas Aquinas, The Angelic Doctor (1225-1274), developed a more elaborate theory of embryonic animation. Needham interprets his views as follows:

> "He had a notion that the fetus was first endowed with a vegetative soul which in due course perished, at which moment the embryo came into the possession of a sensitive soul which dies in turn, only to be replaced by a rational soul provided directly by God" (248, p. 104).

On the other hand, Duns Scotus (1265-1308), here as in many other speculations an opponent of St. Thomas, considered that the embryo contained only the rational soul, which was infused directly into the organism. The views of both of these scholastics led to certain theological difficulties. It was difficult to say how the errors intrinsic in man since Adam's fall could be transmitted to each generation if the soul entered the fetus directly from heaven in each generation (248, p. 105). In a sense this scholastic argument may by some stretch of the imagination be considered the foreshadowing of certain of the heredity-environment arguments of the present day.

In Dante it is interesting to note that a neurological theory comes into play in regard to the animation of the fetus. He says:

> "But how from an animal it becomes a speaking being, thou as yet seest not; this is such a point that once it made one wiser than thee to err, so that in his teaching he separated from the soul the potential intellect, because he saw no organ assumed by it. Open thy heart unto the truth that is coming, and know that, so soon as in the foetus the articulation of the brain is perfect, the Primal Motor turns to it with joy over such art of nature, and inspires a new spirit replete with virtue, which draws that which it finds active there into its own substance, and makes one single soul which lives and feels and circles on itself" (97; 248, p. 106).

After the Renaissance, books on midwifery began to appear, and in these practical treatises there are a number of observations on fetal movements. For information in regard to these views see Spencer's *History of British Midwifery* (302).

The great William Harvey (300) combined in himself a knowledge of classical Renaissance embryology, a practical knowledge of midwifery, and a truly scientific ability in observation. A combination of these various advantages makes his writing peculiarly important in this field. He says in one place, again quoting Needham:

> "I saw long since a foetus, the magnitude of a peascod cut out of the uterus of a doe, which was complete in all its members & I showed this pretty spectacle to our late King and Queen. It did swim, trim and perfect, in such a kind of white, most transparent and crystalline moysture . . . about the bignesse of a pigeon's egge" (248, p. 139).

In all of his work Harvey maintained that growth was a process of continual epigenetic development and not of the unfolding of something preformed in the egg of the organisms considered. Harvey also gave a rather elaborate picture of the activity of the human fetus in which he said, quoting from Spencer:

> "For he swimmeth in a water and moveth himself to and fro, he stretcheth himself now this way, and now that, and so is variously inflected and tumbled up and down, in so much that sometimes, being entangled in his own navel string, he is strangely ensnared" (300, p. 35).

Harvey also noted the fact that the mother can feel the kicks of the unborn child in such a way as to assure her that the fetus does not always lie in the same position.

In 1664 Gregorius Nymmanus wrote in support of the proposition that the fetus in the uterus lives with a life of its own, evincing its own vital actions, and if the mother dies it not uncommonly survives for a certain period, so that it can sometimes be taken alive from the dead body of its mother. The fetus, he continues, prepared its own vital spirits and the instruments of its own soul, there being no nerve between it and the

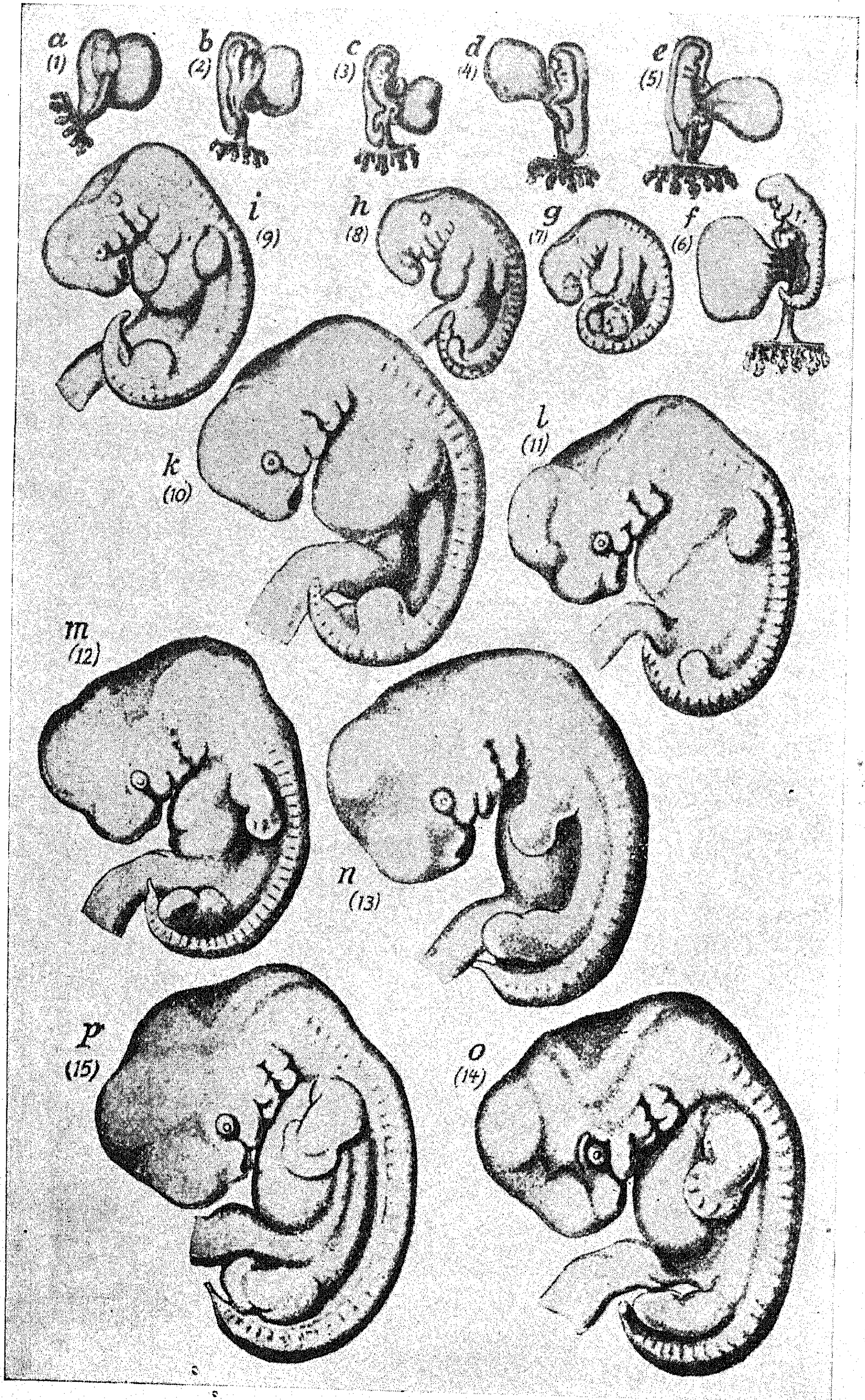
mother. This is demonstrated by the fact that the fetus *in utero* moves during the mother's sleep (248, p. 160).

In the citation just given is seen a combination of the old speculation and the new statement of observation characteristic of the re-birth of science. This combination of attitudes in regard to fetal development comes down almost to our own day, but increasingly as the years have passed the problems of embryology have become questions of observation and not of fancy. For a consideration of certain aspects of the triumph of science over superstition in these matters see Spencer's lecture on the *Renaissance of Midwifery* (301). In the opinion of the present writer there is, however, real significance in the fact that during the long centuries of speculation concerning the "besouling" of the fetus, the point of quickening was often considered as most important. Moreover there seems to be good reason for this. The present writer is as convinced as was Tertullian that the quickening of the fetus is significant in the story of the onset of mental life. Common sense and vulgar tradition are not sure scientific guides, but the observational basis of non-scientific speculation sometimes points to a truth neglected, for a time, by the more exact methods of science.

One of the problems that grow out of the view that the fetus early comes to have an independent existence is the evaluation of human fetal life. This is essentially an ethical rather than a scientific problem, and as such it continues down to the present time to be a significant topic, but not a topic of special interest in this chapter. Among the numerous treatments of this topic the monograph by Hans Goeckel (129) dealing with the changes that have taken place in the evaluation of the life of the unborn human fetus is possibly most important. In this monograph, he reviews primitive opinion and the statements of Roman and old Germanic law in regard to the fetus. He presents an excellent bibliography of Catholic theological pronouncements and of legal opinions on the value of the life of the fetus. The legal aspect of prenatal life is also given especial consideration in a paper by Morache (245). As already noticed, the earlier history of evaluation of fetal life is fully considered in Witkowski's detailed *Histoire des accouchements chez tous les peuples* (349). Much of this work, however, seems to be based upon Cangiamulla's *Embryologia Sacra* of 1775, which the present writer has not seen.

Current speculation in regard to the value of the fetus is found in such papers as those of Arendt (12), Glenn (128), and Hughes (160), which treat various aspects of the ethics of dealing with the life of the unborn child.

From early times the belief has been current that the mother's thoughts and experiences directly influence the fetus. For many years, however, this view of prenatal influence has existed in the popular rather than in the scientific tradition of mankind. That "thought transference" or some mysterious nervous relationship maintains between mother and fetus is not, of course, today held by scientific investigators. Save in the chemi-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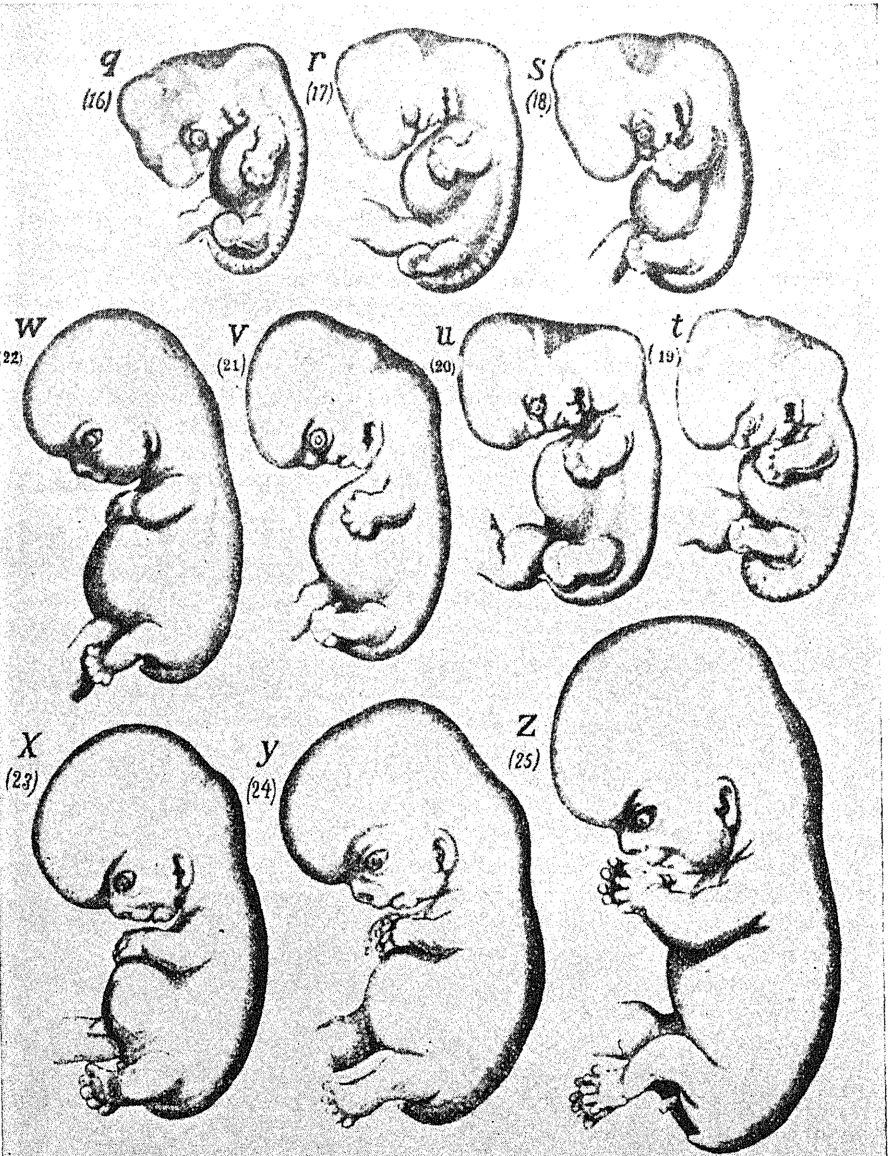

FIGURE 11

THE HUMAN EMBRYO OF HIS'S *Normentafel* AS GIVEN BY KEIBEL AND ELZE (175)

Embryos *a* to *p* are magnified approximately five times. Embryos *q* to *z* are magnified approximately 2.5 times. The letter designating each fetus, its size in mm., and its estimated age in days are as follows: *a*, 2.1, 12-15; *b*, 2.12, 12-15; *c*, 2.15, 12-15; *d*, 2.2, 12-15; *e*, 2.6, 18-21; *f*, 4.2, 18-21; *g*, 4.0, 23; *h*, 5.5, 24-25; *i*, 7.5, 27-30; *k*, 10.0, 27-30; *l*, 9.1, 27-30; *m*, 9.1, 27-30; *n*, 10.5, 31-34; *o*, 11.0, 31-34; *p*, 11.5, 31-34; *q*, 12.5, 31-34; *r*, 13.7, 31-34; *s*, 13.8, about 35; *t*, 13.6, about 35; *u*, 14.5, about 37-38; *v*, 15.5, about 39-40; *w*, 16.0, about 42-45; *x*, 17
52-54; *z*, 23.0, 60.

(From F. Keibel and C. Elze's *Normentafel zur Entwicklu*
Menschen. By permission of Gustav Fischer, publi

cal interchange between the two blood streams or in mechanical or infectious transmissions, biology and psychology offer no basis for this view. Compayré gives a brief history of this superstition including the now amusing assertions of Malebranche in regard to the complete intercerebral sharing of all mental processes between fetus and mother to the speculations current in non-scientific writers at the end of the nineteenth century (85, pp. 32-33). He does not, however, refer to the remarkable assertions of Hegel concerning psychological embryology in which mother and fetus are said to be in undivided "psychic unity." This magic relationship is held to be of the nature of animal magnetism by which the character and talent of the mother are communicated to the child (141, pp. 28-29). That this view is still discussed may be discovered by reading articles by the following writers: Barham (16), Brown (37), Christenbery (57), Walton (325), Coughlin (92), and Tompkins (321). A typical example of such an observation is the following case of Morrison (247). A mother of five healthy children had two teeth removed during pregnancy. She feared that the child would have harelip. She became obsessed with the idea. The child was born with harelip. It proved difficult to convince the mother that maternal impressions were not an accepted scientific cause. In this case just given, one is apparently dealing with an unusual coincidence which seems very like a causal connection to those who emotionally participate in it. To the parent such a conclusion may thus be psychologically if not scientifically pardoned. Until new evidence is presented, however, such cases cannot be considered as having scientific significance.

We must now return to the scientific study of the fetus in order to consider what is known in regard to the actual behavioral development of the unborn child. For the purpose of understanding this prenatal development of human behavior some general idea of morphological development will be found to provide a useful base line upon which to represent the changing continuum of behavior. Figure 11, taken from Keibel and Elze (175), shows a selected series of human embryos and fetuses from 2.1 mm. to 23 mm. in length. The length of each specimen is shown in the legend below the figure.

Many efforts have been made to build a table from which the ages of fetal human organisms could be estimated on the basis of known physical measurements. Scammon, indeed, estimates that there are 7500 titles on the growth and physical development of the fetus, infant, and child (288). The construction of satisfactory norms of growth in prenatal life has proved to be a very hard task because of the difficulties that must be overcome in evaluating the material to be measured. In the first place, even if material of truly known age were plentifully available, each age norm would necessarily be stated in terms of some statistical average, because of the many factors such as genetic stock, nourishment, and specific pathology, which influence fetal size. For a consideration of some of these factors in infrahuman mammals, see the work of Bluhm (27). A

greater stumbling-block, however, than this variability of size at any true age is found in the fact that it is peculiarly difficult in the human individual to place correctly the zero point of development, even though, in the light of the discussion given at the beginning of this chapter, such point be taken as the moment of fusion of the nuclei of the two parent cells. As a matter of fact, this moment can never be absolutely accurately determined and therefore numbers of different ways of approximating the zero point of development have been used in the history of human embryology. Even as yet no complete agreement has been reached in regard to the most desirable procedure in this calculation. Of these methods the following are probably most important: (*a*) *Menstruation age.* In this scale the age of the fetus is calculated from the first day of the last period of menstruation prior to the onset of pregnancy (225). (*b*) *Mean menstruation age.* This age is similar to the above, only it is based on the average calculated from many cases. Thus if 51 days is taken as a mean, there is a possible deviation from 40 to 62 days, so far as the relationship to morphological measurement is concerned (225). (*c*) *Conception age.* The age of the fetus is calculated from the last day of the last menstrual period prior to pregnancy. This is the age used by His and adopted by Minot (243). (*d*) *Copulation age.* This age, based upon calculation and upon trustworthy cases of known copulation time, is found to be approximately ten days shorter than the mean menstrual age defined above (225). (*e*) *Ovulation* age. This age is calculated from the time of ovulation. It is at present extremely difficult to determine directly the time of ovulation, these determinations being complicated by many factors such as the fact that it is difficult to know how long spermatozoa may live after entering the female genital tract (225). (*f*) *Fertilization age, or true age.* This age can never be directly determined, but must be calculated from *a, b,* or *d,* above. In general, it may be said that the present evidence points to the fact that fertilization occurs in less than forty-eight hours after copulation (225).

A standard table of age-length equivalents during the prenatal period of development is still further complicated by the fact that the linear measurements of the specimens have been obtained by the use of different methods. The measurements commonly used include the crown-rump length, and crown-heel length, or standing height. The second of these is really related to the first, that is, it is crown-rump length added to the rump-heel length (244). Beside these two usual measurements, there is the *Näckenlange* of His, that is, the length measured from a particular point in the caudal bend to a particular point in the neck-bend of the specimen (151).

Of these measurements the crown-rump measurement is possibly best for embryological purposes (244), but in most of the work on the development of behavior the crown-heel length has been employed (238, p. 477; 241, p. 531). [Cf. also (289).]

In a subject so full of possible divergences of opinion, therefore, it is

TABLE 3

ABBREVIATED DATA FROM MALL TO SHOW RELATIONSHIP BETWEEN VARIOUS AGE DETERMINATIONS OF THE FETUS AND *CH* (CROWN-HEEL) AND *CR* (CROWN-RUMP) MEASUREMENTS OF HEIGHT IN MM.

(Abbreviated from F. Keibel and F. P. Mall's *Manual of Human Embryology*, Vol. 2, p. 199. By permission of J. B. Lippincott Company, publishers.)

Probable age in weeks	Probable age in days	Mean menstrual age	Mean length of embryo (*CH*)	Mean length of embryo (*CR*)
1	7			
2	14			
3	21	31	.5	.5
4	28	37	2.5	2.5
5	35	43	5.5	5.5
6	42	51	11	11
7	49	59	19	17
8	56	65	30	25
9	63	72	41	32
10	70	79	57	43
11	77	86	76	53
12	84	94	98	68
13	91	100	117	81
14	98	108	145	100
15	105	114	161	111
16	112	121	180	121
17	119	128	198	134
18	126	136	215	145
19	133	143	233	157
20	140	150	250	167
21	147	157	268	180
22	154	165	286	192
23	161	171	302	202
24	168	177	315	210
25	175	185	331	220
26	182	192	345	230
27	189	199	358	237
28	196	205	371	245
29	203	212	384	252
30	210	219	400	265
31	217	228	415	276
32	224	234	425	284
33	231	241	436	293
34	238	248	448	301
35	245	256	460	310
36	252	262	470	316
37	259	271	484	325
38	266	276	494	332
38 4/7	270	280	500	336

little wonder that many apparently conflicting tables of age-length relationships have been produced. Among the tables frequently referred to are those of Jackson (168), Preyer (and the other embryologists summarized by him), given in Minot (243, p. 381), and the summarizing table from Keith (177). Instead of giving all of these tables and many others to which reference might be made, or of attempting any averaging of the results, it has seemed wise to present the table of Mall, for it seems to the present writer to be based on excellent evidence (224). This table, which is based on Mall's own work and upon the collection of material by Issmer, is given as Table 3. Mall has reviewed his work

subsequent to the publication of this table and still finds the table accurate (225). It should be noted, however, that particularly so far as the younger stages are concerned there is a possibility of great variability in judging age from such a table as that given. Weight is probably a better index but is seldom given (243, p. 381). Therefore, in all age determinations given in this paper, it should be borne in mind that the word *approximate* should really be placed in front of almost any statement of fetal age. Gesell has considered the problem of human age in relation to infancy (124, pp. 315 f.).

Growing immediately out of the relationship between growth and age of the fetus are a whole series of studies on the morphological development of the fetus, which of course cannot be reviewed in this chaper. Figure 12 shows graphically the significance of such knowledge for one who thinks of the fetus as a "smaller infant." The literature on general fetal development has several times been summarized, the early work having been brought together in an excellent summary by Pinard (272) in 1877. In this summary the work on the morphology, physiology, and pathology of the fetus is treated separately. A bibliography of 870 titles is appended to this treatise. Following the summary of Pinard, the next important one is that of Wertheimer (337) which brings the general literature on the fetus together to 1904. Probably the most complete summary in English of the anatomical and physiological aspects of fetal development

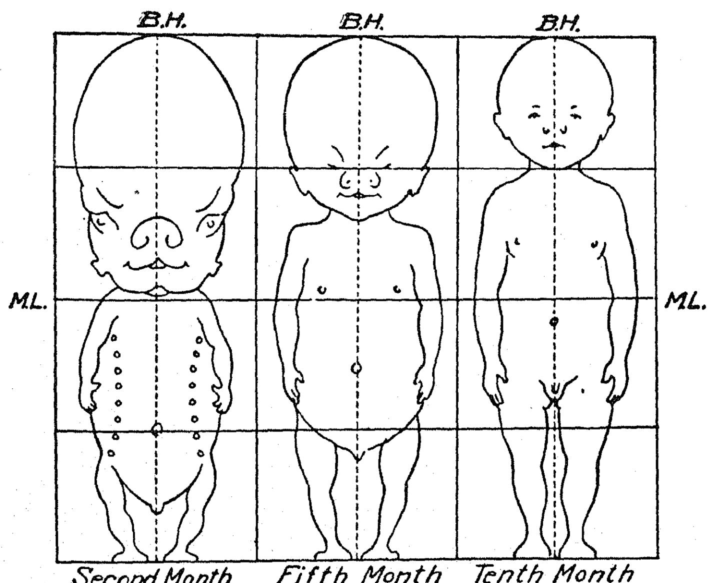

FIGURE 12

CHANGES IN BODY PROPORTIONS IN FETAL LIFE

B.H., body height; *M.L.*, midline

(From J. H. Hess's (146) *Premature and Congenitally Diseased Infants*, p. 36. By permission of Lea and Febiger, publishers.)

is that of Feldman (118), which, in spite of certain lacunae, should be read by all who are interested in the fetus.

As pointed out above, it may almost be said to be necessary, in order to understand the development of behavior, to have some reference line in terms of measurements of anatomical development. Following such a temporal line, it has become a convention to divide the prenatal life of the human being into three periods, the first one or sometimes two weeks being spoken of as the *germinal period,* that from the third to fifth or sixth week as the *embryonic period,* and that from the sixth week to birth as the *fetal period* (118, p. 61; 340, p. 163). The normal term of pregnancy is usually placed at 280 days (340, p. 163), although estimates varying between 270 to 284 days have been given by various investigators summarized by Needham (248, p. 486). It must be obvious, however, that such figures are meaningless unless the method of calculating true fertilization time is given. The normal length at birth is ordinarily given as 500 mm. in crown-heel, or 320 mm. in crown-rump, length. Premature infants, however, are sometimes born and successfully reared that have passed less than 180 days in the mother's body, but 180 to 181 days are usually taken as the average lower limit below which viability cannot be maintained (146). Claims have been made that much younger fetuses have been raised, but as, for example, in the case of Rodman's fetus which was alleged to have been but four months of age, there is much doubt as to the accuracy of the estimation of age (14, 284). On the other end of the scale the terminal point of postmaturity is also open to great difficulty of estimate. In considering this matter, Ballantyne and Browne hold that no single index such as fetal length, weight, ossification of the skeleton, placental structure, or cord structural condition is sufficient to date the fetus. They hold that the best estimate is secured by combining a knowledge of the last menstrual period, the date of copulation, the date of the onset of morning sickness, the date of the quickening of the fetus, the size of the uterus, the difficulty of delivery, as well as the evidences of postmaturity such as measurements of length, weight, and ossification. Probably 334 days is the longest period legally considered during which a fetus may be thought possibly to have lived in the mother's body and still be delivered alive (15, p. 198). Thus, from one point of view at any rate, the human fetal life-span that will be dealt with in this paper must be taken as lasting from fertilization until birth, a time which in the extremest possible cases may vary by as much as 154 days!

In this paper most of the references to fetal behavior will be made to the unborn fetuses, but it must be kept in mind that the study of correctly dated premature infants may throw much light upon the later fetal period. It should be remembered, however, that in interpreting the sensory ability or response activity of a prematurely born infant, it is not safe to attribute the same abilities to the unborn fetus of the same age. As suggested in the first part of this paper, the greatest errors in genetic science are made by suggesting that because environmental conditions of one sort

produce behavior of a particular kind in one individual, therefore these same abilities must be "implicit" in an organism living under wholly dissimilar conditions. A normal fetus of the same age as a premature infant may act in a very different way than does a premature infant. This is not only because of possible mechanical differences of bodily make-up, such as liquid in the ear, but because of the gross differences brought about by the change from placental respiration to pulmonary respiration, and from placental nourishment to alimentary-canal nourishment. The sheer mechanical change from life in a liquid with the specific gravity of the amniotic fluid to air is also important. Similarly, the effectiveness of external stimulation is vastly changed in the transition from the relatively constant stimulus world before birth to the continual change and variety of physical energies affecting the body after birth. An excellent brief summary of the development of the fetus week by week is given by Williams (340, p. 163). In the present chapter, save for the tables of

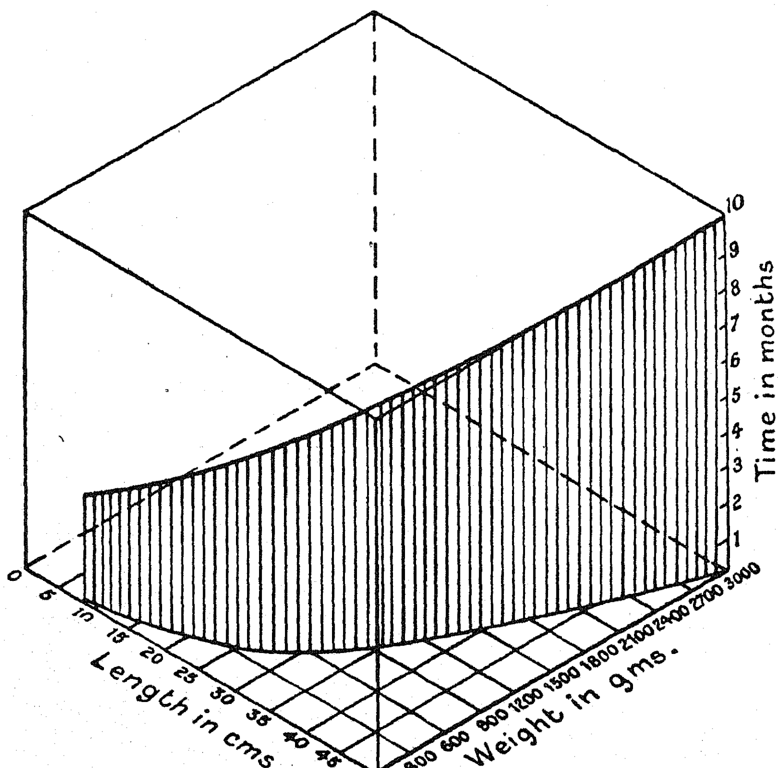

FIGURE 13

THREE-DIMENSIONAL ISOMETRIC PROJECTION FROM WHICH HEIGHT, WEIGHT, AND AGE OF HUMAN EMBRYOS MAY BE READ OFF IF ONE IS KNOWN

(From Scammon and Calkins as redrawn and published in J. Needham's (248) *Chemical Embryology,* Vol. I, p. 382. By permission of the University Press, Cambridge, publishers.)

fetal length and age, and save for the reproduction of the famous Keibel and Elze series of embryos and fetuses given above, no detailed consideration can be given to gross structural change which occurs during prenatal growth. Possibly the best graphic representation of prenatal physical development is that of Figure 13 reproduced from Scammon and Calkins and redrawn by Needham (248, p. 382) in which the age, height, or weight can, to the limits of accuracy of the original data, be read off if any one of these measurements is known.

Therefore, for the most part assuming morphological change, a review will be given in the rest of this chapter of the development of behavior in human fetal life. In the first place, brief consideration will be given to clinical observations on fetal movement made without operation or the interruption of pregnancy. Following this, as accurate and complete a summary as possible will be given of the experimental studies on the development of behavior in the operatively exposed embryo. After these two lines of evidence in regard to fetal behavior have been given, a review of the knowledge in regard to human fetal sensory life will be presented. A knowledge of sensory development will at once lead into a consideration of the theories that have been proposed to account for the development and control of fetal behavior, and an evaluation of such observations for psychology will then be presented.

VI. Non-operative Studies of Behavioral Development in the Human Fetus

A number of different methods have been used in the scientific study of the development of the human fetus without disturbing its normal course of development. The simplest of these are the direct reports of the mother concerning the movements of the fetus which she directly experiences. The mother can sometimes perceive the "quickening of the fetus" by the seventeenth week (118, p. 204). Sometimes the physician can by the use of the stethoscope hear fetal movements as early as the fourteenth week (249, p. 292; 222, p. 258), although it is probably more customary to say that the first time at which such movements can be detected by the physician is in the fifteenth or sixteenth week (118, p. 204). Feldman points out that in fetuses of eight weeks the umbilical cord shows regular spiral twists (118, p. 204). As such twists are not characteristic of animals that carry many young and therefore have little room for the fetus to turn in, it is assumed that the movements of the fetus even at such a young age determine the twisting of the cord. The present writer, however, can see no reason why such twisting may not result from passive as well as from active movements.

In later periods of pregnancy, reports of movement involving part of the body are given. Sometimes movements of the extremities or of the trunk alone are noted. Mermann, for example, reports a case of rhythmic movement of the fetal back palpated through the mother's abdominal wall in a fetus of seven months (232, p. 623). Whitehead gives an extended

report of a case of violent convulsion of the fetus while still in the uterus (339). This convulsive condition occurred during the ninth month of pregnancy. The activity of the fetus caused the mother great pain. By palpation and by direct observation it was found that the fetus was in a state of marked hyperactivity. Both the head and limbs of the fetus were moved so violently as to cause active disturbances of the body wall of the mother. The child, born twenty-one days later, was in all respects healthy and vigorous.

Palpation and various instruments for magnifying or recording various fetal movements observed through the intact body wall of the mother have long been in use. MacKeever, as early as 1833, pointed out that the stethoscope was a valuable instrument in this connection (217). The direct hearing and registering of fetal heart beat also has long been a subject that has attracted the attention of clinicians. Feldman says that this phenomenon was discovered by a Swiss physician (118, p. 157), but its importance was first brought out by de Kergaradec in 1822 (101). This student concluded that the fetal heart beat could be heard from the eighteenth week of pregnancy on. Mailliot thought that it could be heard much earlier (222, p. 258). Recently, among others, DeLee (102) and Hyman (162) have made special studies of the fetal heart beat, including such phenomena as irregularities in its rhythm. In 1891 Pestalozza succeeded in taking a cardiograph of the second twin after the first twin had been born (see 118, p. 159). This effort was more successful than that of Hicks (148) in 1880, in which by the use of an instrument like a cardiograph certain records were obtained, but they were so badly obscured by the rhythmic activities of the mother that they could scarcely be identified. Krumbaugh and Jenks are reported by Feldman (118, p. 162) as having obtained typical electrocardiographic tracings of the fetal heart. More recently Maekawa and Toyoshima (218) have, by the use of modern amplifiers and a string galvanometer with electrodes placed on the front abdominal wall of the mother, secured excellent electrographic tracings of the fetal heart. After birth the beat of the same heart is also recorded for comparative purposes.

Among the other early movements of the fetus which are often directly recorded are the so-called *Ahlfeld breathing movements,* or the rhythmic contractions of the fetal thorax felt through the mother's body. These movements should not be confused with uterine contractions occurring after the third month, sometimes called *Ahlfeld's sign,* which incidentally may have something to do with the onset of behavior, an analogy suggested with the amnion contraction of the chick noted above (189, p. 263). In spite of the difficulty of the ancients concerning fetal respiration that involved the intake of no air into the lungs, it has of course long been understood, as Leonardo da Vinci knew, that the fetus does not breath water (248, p. 108). The gaseous interchange of the mammalian fetus occurs in the placenta between the blood stream of the mother and that of the fetus. The general significance of this process and its detailed consideration have

been studied by many physiologists. The history of the early advance of knowledge in regard to this matter is summarized by Starling (303), and the present status of the facts in regard to the fetus are brought together by Sarwey (287). [See also (42).]

The liquid environment, of course, completely precludes true lung breathing, but at least since 1798 movements of the chest and thorax of the fetus similar to breathing movements have been occasionally noticed. In 1815, Leolard (210) observed such movements in various mammalian embryos without removing the amniotic sac through which they were observed. In a number of papers Ahlfeld (2) has developed a view in regard to the nature and significance of certain irregular but vaguely rhythmic movements of the fetus which seem to be caused by the contraction of the same muscles which will later make respiration possible in postnatal life. [See also (185, 178).] Ahlfeld has made graphic records of these movements, which in typical cases vary from 38 to 76 per minute. Teleologically, it has been suggested that these movements may be thought of as preparation for the act of breathing which comes at birth. In the fetus such movements are considered to lead only to the ebbing and flowing of the amniotic fluid in the trachea, but, as movements, they exercise and strengthen the neuromuscular mechanism of breathing. Possibly this behavior is related to the establishment of the rhythmic action of the respiratory centers of the central nervous system. The conception has been proposed, therefore, that birth is not to be considered as the point at which the onset of rhythmic respiration occurs. Carrying this idea further, it has recently been suggested that these prenatal chest movements are initiated, like adult breathing movements, by a change in the concentration of metabolites in the blood stream acting upon the breathing centers of the central nervous system (39). Combining the views in regard to fetal breathing movements and their cause, it has been suggested that the active or passive general bodily movements of the fetus may occasionally be such as to impede circulation in the umbilical cord. This mechanical obstruction of the umbilical cord, therefore, leads to an increase in carbon-dioxide tension in the blood. This in turn may lead to a facilitation or activation of appropriate centers in the brain, and thus initiate movements whereby the mechanical relationship of fetus and cord is changed in such a manner as to re-establish placental circulation (39). It has even more speculatively been suggested that the chest movements of the fetus are not only part of the general movements which bring about a change in the position of the organism, but that these very chest movements act as a supplement to the fetal heart. They thus may act, it is suggested, as a sort of auxiliary pump brought into play as a result of a change in gas tension in the blood acting upon the breathing center (326, p. 334).

If these speculations are in any sense correct, therefore, the so-called first breath of the child may be just a change in the way in which the same neuromuscular mechanism determines the oxygenation of the blood (326, p. 341).

A number of investigators have severely criticized the Ahlfeld concept of prenatal breathing movements. A recent German author has attributed these objections to the fact that the initial statement of Ahlfeld's view was unfavorably received by the two leading obstetricians of Germany at the time, and that the weight of authority long kept this phenomenon from being correctly evaluated (326). It should be noted, however, that Huggett in an experimental study of fetal respiratory reflexes referred to above says: "The exact mechanism suggested by Ahlfeld is not in every sense confirmed" (159).

A good many speculations have been made as to the causes involved in the first intake of air breath. As noted above, many students have held that the increase of metabolites, and especially of carbon dioxide tension in the blood, is one of the essential causes of the first gasp (86). Cohnstein and Zuntz (83) observed in a fetal lamb that clamping of the umbilical cord led to the first intake of air. The present writer has noticed this in fetal cats, rats, and guinea pigs. Indeed, the procedure of clamping the umbilical cord to study the effect of the blood stimulus on general bodily movements has been part of the experimental technique of several recent investigators and notably so in Swenson's (311) study of the fetal rat. The general result of this procedure seems to be an increase in amount and vividness of activity for a time. Pflüger, however, held that some external stimulus, such as cold air, was necessary besides blood change to bring about the first breathing act (cf. 159). Preyer also suggested a relationship between cutaneous stimulation of some sort and the onset of breathing (277, p. 452). Corey (86), a recent student of this phenomenon, holds that an increase in the metabolites of the blood stream and some external stimulus, such as drying of the skin, seem to be in most cases antecedent to the initial respiratory gasp.

Besides "breathing movements" there are other movements of the fetus which are indirectly significant in behavior. The movements of the organs of the digestive tract as seen in fetal organisms have been studied by a number of investigators. Yanase has studied peristaltic intestinal movements in fetal guinea pigs, cats, rabbits, and men. As a result of these studies, he concludes that peristaltic movements may begin long before birth. In man such movements are possible in the seventh week (352, 353). So far as hunger contractions are concerned, Patterson has shown that hunger contractions are practically continuous in young dogs. As age advances these contractions decrease in magnitude (265). Carlson and Ginsburg, working on fetal dogs and newborn children, have shown that "the empty stomach at birth and in the prematurely born exhibits the typical periods of tonus and hunger contractions of the adult, the only difference between infant and adult being the greater frequency and relatively greater vigor of these periods in the young" (45, p. 29). For other aspects of the function of the stomach before birth, see Sutherland (307). Certainly, in view of the large amount of work on the "hunger drive" as a determiner of activity, part of which is summarized

by Warden (327), the possibility that these stomach and intestinal contractions are stimuli to "random" and "spontaneous" skeletal muscle movement, and indeed for much of the behavior of the premature or full-term infant, cannot be neglected by one who would understand fetal behavior.

The question has often been raised as to whether or not gross external fetal movements of the various sorts considered above have any part in the rearrangement of the fetus in the uterus in the normal position for delivery at birth. As is so often the case in regard to a phenomenon which is difficult to explain, it has been alleged that the position of the fetus is caused by instinct (111). More recently, however, mechanical and physical explanations have been advanced by Paramore (258), McIlroy and Leverkus (231), Barnum (17), Griffith (134), and others. Possibly it may be said that no absolutely positive proof has been advanced to show that active fetal movements are essential in determining the normal position of the fetus at the time of delivery.

In the study of the changes of fetal position before birth, much has been learned by the use of the X-ray. We have already seen that Avery attempted to study the changes in position of guinea pigs by the use of roentgenograms. This work of Avery's was directly adapted from human clinical work used in the study of the human fetus. The use of the X-ray in the study of the fetus has given a new clue to the determination of fetal age by the study of the ossification of the fetal skeleton, although it is by no means an absolute clue. Hess has brought together much of the literature on this subject and suggests approximate norms of ossification at certain periods (145). [See also Adair (1) and Mall (223).]

A phenomenon of prenatal and immediately postnatal behavior which has long attracted attention is the first cry of the human organism. Kant (173) found significance in the first sound uttered by the human infant. Preyer, indeed, quotes Kant as saying:

> "The outcry that is heard from a child scarcely born has not the tone of lamentation, but of indignation and of aroused wrath; not because anything gives him pain, but because something frets him; presumably because he wants to move, and feels his inability to do it as a fetter that deprives him of his freedom."

Both Preyer (278, p. 213) and Compayré (85, p. 89) have pointed out the futility of such verbal fancies. Such speculation is not as yet entirely dead, however. An analytical psychiatrist has recently written of the cry of the human infant at birth, "It is an expression of its overwhelming sense of inferiority on thus suddenly being confronted by reality, without ever having had to deal with its problems," quoted by Blanton (24, p. 458). By operative technique Minkowski has found that crying occurs as early as the sixth month in the prematurely delivered fetus (237, p. 754). In clinical practice many cases of *vagitus uterinus,* or fetal crying, have been reported. A typical case is that reported by Graham (132), in which in a difficult delivery, the fetal sac having been ruptured by operative means used to assist delivery, the crying of the still unborn fetus could

be distinctly heard. Many such cases are reported but they need not be reviewed here. [See also Feldman (118, p. 207).] Fetal hiccup has also been reported by a number of observers. These cases are summarized by DeLee (103).

All cases of fetal crying reported above seem to be the result of appropriately activated muscles, thus bringing about the expulsion of air in such a way as to cause it to vibrate. There seems to be no reason to assume that this phonation has any greater mechanistic significance than many of the other random acts of the child. Its only significance lies in the fact that from such behavior language develops in later life. This function is, of course, one of the most important aspects of human behavior, an aspect which will in itself come to be, at least in the subvocal stage, peculiarly important even in strictly introspective psychology.

This concludes the consideration of human fetal behavior of the sort that can for the most part be studied during the normal course of development. In the next pages the study of development of human fetal behavior in fetuses removed from the uterus before the normal term of gestation will be considered.

VII. The Study of Behavior in Operatively Removed Human Fetuses

Most of the living human fetuses to which reference will be made below have been removed while still alive from the mother's body, because some disease of the mother rendered the artificial termination of pregnancy medically necessary. Minkowski's technique is typical (241, pp. 518-532). This investigator and a collaborator remove each fetus that is to be studied by a Caesarean section, usually performing the operation under a local anaesthetic. The fetus, placenta, and amnion are removed. The fetus is then placed in a bath of physiological salt solution at normal blood temperature. This means that such fetuses are cut off from their oxygen supply and the movements which result must be thought of as the movements of increasingly asphyxiated organisms (241, pp. 526-528). This is important in the evaluation of the behavior reported for, as pointed out above, increased metabolites in the blood at first lead to hyperactivity and then to hypoactivity.

In this chapter the behavioral development of the human fetus as determined in operatively removed cases will be considered in two series. First, the development will be given in relation to the linear measurement of the fetus, and, secondly, in regard to the assumed age. It may seem to the reader that these two series might advantageously be combined, but the reports of development of fetal behavior are for the most part in the form of incomplete published protocols and it has proved impossible to bring all of the material together into one series, for some observations are given in regard to a fetus of a certain length and some in regard to a fetus of a certain age. An effort has been made, however, to make the second developmental series, that on the base line of time, in a certain sense a summary of the first. The present writer has attempted to make a summarizing table of human fetal development, but he did not feel that such

a table gave a correct impression of fetal development. One, however, who wishes to see this material expressed as well as possible in tabular form should consult Coghill (74, pp. 993-996).

Behavioral Development According to Measured Length. The development, then, of human fetal behavior as observed by various investigators in relation to the length of the fetus may be given as follows:

Fetuses below 30 mm. in length. In young human fetuses thus operatively removed from the mother, the first movement observed is that of the beating heart. For several centuries there has been a scientific controversy as to whether or not the heart beat of the adult individual is to be thought of as essentially determined by direct muscle or by neural stimulation. It now seems that the early embryonic heart beat must be thought of as essentially an independent muscle contraction (259, pp. 50-63). Therefore, in most of the work on the development of behavior the beating of the heart is not considered as marking the onset of "true behavioral life." Pflüger (271) has demonstrated the beginning of heart beat in the fetus as occurring in the third week, that is, in a fetus of approximately 4 mm. [See also (305, p. 951).]

Much is known of the structural and minute functional development of the receptors, nervous system, and effectors in all embryonic and fetal stages. It is not, however, until a fetus of 15 mm. is reached, so far as the writer can discover, that any direct statement is made in regard to the activity of any part of the response mechanism, and this is a negative statement. In a fetus of this length, Minkowski reports that it was impossible to bring about muscular response even to an electric current of 40 milliamps. He made observations on two fetuses of this length with the same conclusion (242, p. 66).

This is not entirely unexpected, as Hewer has shown that, histologically, the musculature of the fetus develops at uneven rates, the unstriped musculature being first to develop, being clearly formed in an embryo of 1 mm. Striped musculature could not be made out in a fetus smaller than 2.5 mm. in length, and it did not take on its definitive characteristics in fetuses younger than twenty-two weeks. Special changes of structure are also noted by this same investigator in regard to heart musculature (147).

Possibly the youngest human fetus to be observed to move is one reported by Yanase in his studies of the development of intestinal movement noted above. In a fetus of 20 mm., of an estimated age of six weeks, one movement involving the right arm is rather casually noted (353, p. 455). The next youngest human fetus to be reported moving is a fetus of 22 mm., reported by Strassmann in a case of extra-uterine pregnancy. He observed through a rupture in the tube wall slow movements, backwards and forwards, of the arms and legs of the fetus (305, p. 963). In evaluating this observation it should be noted that Strassmann's report is given in a manner possibly to lead to a questioning of his observations, since apparently the fetus was observed in such a way that rhythmic mechanical movement from the adult body was possible. Certainly, all observers of

fetal behavior have had difficulty in deciding that they were seeing something which was not the result of passive external mechanical movement. It should be borne in mind, therefore, that possibly these two earliest observations should be substantiated before they are finally accepted. In a fetus of 30 mm. Minkowski observed a worm-like movement of the arms, legs, and trunk (238, p. 477).

Fetuses from 35 mm. to 99 mm. In a fetus of 35 mm. Minkowski reports muscle contraction to galvanic current (242, p. 65). Minkowski's work shows that fetuses of 40 to 50 mm. sometimes still show this characteristic muscle response possibly without neural activation. This observation coincides with the observations noted above on the fetuses of lower mammals, in which the musculature comes to respond to direct stimulation before true neuromuscular action begins. The most elaborate studies of this sort of muscular response have been made in a series of studies by Wintrebert (347, 348). [See also (239, p. 244).]

Among the many significant anatomical observations that might be made at this period, it is interesting to note that the vestibular apparatus seems to be anatomically developed to its full (237, p. 753).

A fetus of 42 mm. was removed under operation by Woyciechowski in order to interrupt a pathological pregnancy. At the operation a mass was removed from the uterus. As soon as the mass was taken out, a fetus of 42 mm. dropped from the excised sphere of tissue. This fetus, estimated by the operator to be approximately two months' gestation age, was seen to move both arms and legs spontaneously. When it was touched by the finger an energetic "protective movement" began which involved a much stronger moving of the arms and hands and an opening of the mouth. The observations made upon the movement of this fetus were checked by another observer. In spite of cooling, the movements of the fetus lasted in an active form for more than five minutes (351, p. 410).

In fetuses of 50 to 55 mm. Minkowski noticed slow, asymmetrical, arhythmic, non-coordinated movements (235, p. 148; 237, p. 723). He also notes that at this time neurologically the elements of the spinal reflex arc are anatomically developed (237, p. 753).

Bolaffio and Artom studied a fetus of 55 mm. They report that dropping the fetus from a height of a few centimeters to the table led to live contractions of the flexor muscles of the limbs. Further, they note that tapping the table lightly with the fingers gave responses of energetic movements involving the elevation of the scapulas, movement of the arms, flexion of the thighs and of the legs. These movements were elicited for about three minutes, after which time they rapidly diminished in intensity and ceased. During the active period, stimulation by a blunt metal rod of the skin of the breast and of the abdomen led to no response. After the cessation of activity direct brain stimulation led to no muscle response (29, p. 465).

In a fetus of 65 mm. Minkowski reports that percussion of the patellar tendon resulted in contraction of the quadriceps muscle. After this con-

traction had taken place, irradiation followed to other muscles. In this fetus the heart beat was relatively constant at 80 beats per minute, but covering the fetus with normal salt solution at 40° C. led to an increase in the beat of the heart from a basal beat of 80 to 100 beats per minute (237, p. 752). Extirpation of the cerebral hemispheres in this fetus did not change the reflexes described. Sectioning the medulla just above the cord region, however, abolished the reflexes due to change in the position of the body (237, p. 752).

In a fetus of 70 mm. Bolaffio and Artom report that stroking and tapping elicited slow local contractions of all the muscles of the limbs. For example, if these stimuli were applied to the palm of the hand, they got adduction and internal rotation of the corresponding arm; if to the leg, flexion of the corresponding thigh. They note, moreover, that mechanical stimulation of the cortex in this fetus gave a constant movement of elevation of the left shoulder, but no contraction of either of the lower limbs or of the right shoulder. After this same fetus was decerebrated they note a greater vividness (*vivacitá*) of the local contractions referred to above and the reappearance of diffusion of movement at a distance from the stimuli which had ceased. In this preparation mechanical stimulation of the medulla led to respiratory movements.

These same authors report in regard to another fetus of 70 mm. that light stimulation of the skin of the whole body was followed by no response, but percussion led to definite responses. Definite percussion blows on the forearm sometimes led to flexion, adduction, and slight internal rotation of the arm. Percussion in any part of the lower limb led to flexion and adduction of the thighs with slight flexion of the legs. If the percussion is rather light, the contractions are limited to the homolateral limbs. If somewhat more energetic, contractions also of the heterolateral limbs are reported. Percussion on the breast and abdomen gave homolateral responses about the pectoral muscles and bilateral responses about the abdominal muscles (29, pp. 465-466).

After decerebration in a fetus of 90 mm. Bolaffio and Artom found a progressive change in response. After superficial and deep stimulation of numerous points on the body, they at first recorded very vivid contractions of apparently all muscles. After about three minutes, however, the contractions were still bilateral, but limited now to segments and homologous regions of the body. As time passed, the contractions became more and more circumscribed and after about three minutes they were limited to the muscles corresponding to the stimulated point. After fifteen minutes every reaction had ceased (29, p. 466).

Fetuses from 100 mm. to 199 mm. Minkowski, studying a fetus of 110 mm., records the fact that a touch of the lower lip or tongue with a blunt probe led to a closing of the mouth, brought about through the lowering and lifting of the jaw (237, p. 723). He also noticed in the same fetus that reflexes of the trunk and extremities were seen prominently, but after the transection of the cord in the dorsal region the lower reflexes

were discontinued at once. This seemed to prove that conduction of activation in this case, at any rate, was through the cord. After this operation, moreover, he noticed that the short reflexes remained unchanged but were themselves abolished after total extirpation of the cord. Destruction of the lumbar and sacral cord abolished the hind-limb reflexes, whereas similar destruction of the cervical cord abolished those of the forelimbs.

In a fetus of 135 mm. Minkowski notes that a touch on the skin, using a blunt stimulus, led to reactions of diverse parts of the body. Characteristic of such stimulation were the flexion of both arms, the repeated opening and closing of the mouth, and simultaneous retraction of the head. He notes that at this stage of fetal development every part of the skin can act as a reflexogenous zone for various reactions. These reactions, however, tend to spread more or less over the entire fetal organism (237, p. 723). Direct muscle excitability still remained at this stage one hour after the cord had been extirpated (237, p. 752). Total removal of the cerebral cortex did not change the observable responses noted above. Transection at the midbrain, however, seemed to weaken the responses, although they still continued.

In a fetus of 160 mm. Minkowski reports spontaneous dorsal flexion of the great toe, although he could secure no direct response to the touch of the sole of the foot. Distinct contractions of the abdominal walls were evoked in this fetus by brushing (237, p. 723). Touching the closed eyelid in this fetus evoked a contraction of the orbicularis muscle.

Erbkam (115), writing in 1837, reports a study of a fetus, accidentally delivered, of approximately 170 mm. in length. In this fetus he noted the contraction of both arms and legs, the movement of the head from side to side, "as if to breathe." In this fetus the heart beat for ten minutes. After that time the water in which the fetus was lying became cool and the heart beat became slower. When more warm water was poured in, however, the heart beat became lively. The eyes of this fetus were closed. Johannes Müller saw the fetus and agreed with the author that the fetus was approximately four months in fetal age.

In a fetus of 180 mm. Minkowski noted spontaneous movements of all the extremities and the head. These were noted before the umbilical cord was ligated. In this fetus, touching the sole just at the time of delivery led to the dorsal extension of the big toe, the Babinski reflex. Later the plantar flexion followed (238, p. 486; cf. also 241, p. 551).

In a fetus of 190 mm. Minkowski secured definite indication of reciprocal muscle innervation (239, p. 250). He also reports at this stage that diagonal reflexes were established, that is, stimulating one foot of the fetus would lead to the movement of the arm on the opposite side. In certain instances the stimulation of the sole of the foot on the one side even led to the movement of one finger, the little finger, on the hand of the opposite side of the body. These diagonal reflexes are considered by Minkowski as significant in relation to the trotting reflex noted by a number of students of the genetic development of locomotion (237, p. 723).

Fetuses 200 mm. to 500 mm. (average length at birth). In several fetuses studied by Minkowski, of approximately 200 mm. in length, brushing the sole of the foot was found to lead to plantar flexion of the toes, except the big toe, which did not move (see 241, pp. 550-556; 238, pp. 478-480; 237, p. 723). Direct mechanical stimulation of the motor roots of the spinal nerve at this stage showed that intersegmental spinal conduction is already established (237, p. 752). Mechanical stimulation of the cranial nerves at the level of the medulla was also found to lead to the opening and closing of the mouth. It is presumed by Minkowski that this followed from the direct stimulation of the facial nerve (237, p. 752).

In a fetus of 210 mm. Minkowski observed opening and closing of the mouth accompanied by arm movements. The duration of such movements at this period was directly limited, seldom lasting more than one minute at the most (237, p. 723). In a fetus of 230 mm. Minkowski notes for the first time continued rhythmic contractions of the sort often described as Ahlfeld's breathing movements (237, p. 723).

In a fetus of this same length Bolaffio and Artom note that by employing superficial stimulation they were able to get localized muscular contractions about the limbs and other specialized muscle groups. By using strong and deep stimulation on a single segment of the limbs, they got contraction in flexion of the whole corresponding limb. They also note that stroking the ridge of the tibia gave vivid adduction of the homolateral thigh. Mechanical stimulation of the Rolandic zone of the brain, either through the cranial cap or after its removal, still, however, did not call forth any reaction. Removal of the hemispheres led to more vivid local responses than in preceding excitations. Stroking the pectoral muscles called forth adduction also of the contralateral limb. If the intensity of the stimuli was increased somewhat, these investigators report that they got contraction of the whole corresponding limb. By stimulating the medulla they were able to call forth violent respiratory movements with active participation of the cervical, thoracic, and abdominal muscles, and those of the diaphragm. These movements were so violent they also led to elevation of the shoulder and adduction of the arms. It is further significant to realize that these investigators find, after repeated successive experiments and as the vitality of the fetus becomes weaker, that the muscular contractions disappear first in the lower limbs and then later in the upper limbs (29, p. 466).

In a fetus of 240 mm. Krabbe, in a study made in 1912, reports slow movement of the limbs and contraction of the muscles as the result of percussion. He also obtained strong abdominal reflexes as the result of light blows. The plantar reflex occurred without involving the participation of the big toe. In the fetus which he investigated the heart beat was strong and he was able to elicit a number of reflexes, the abdominal reflex being especially strong. The fetus was a female, but he was unable to elicit the female cremasteric reflex. He felt that both bone and tendon reflexes

were present and was able to demonstrate that direct muscle stimulation was possible (186, p. 434).

In a fetus of 260 mm. Bolaffio and Artom attempted certain specific neurological experiments. By means of appropriate electric stimuli they explored the cortex but did not obtain any reaction even with intense stimulation. By operation the internal capsule and peduncles were exposed, but still electric stimulation gave no response. When they reached the pons, however, they got ready and synchronous responses from the muscles innervated by the facial nerve. Finally, stimulation of the medulla, however, gave energetic respiratory movements. Stimulation of the cervical cord gave energetic movements of elevation of the shoulder with flexion of the upper limbs, and stimulation of the lumbar cord gave movements of the lower limbs (29, p. 466).

In a fetus of 270 mm. Minkowski notes that from the first the plantar flexion of the toes was present to stimulation of the sole of the foot. Minkowski is of the opinion that at this age the plantar flexion must be thought of as a pure spinal reflex (237, p. 754).

In a fetus of 280 mm. Minkowski was able to bring about rather elaborate but quite well-differentiated muscular responses to single electric stimuli. For example, the muscles of the eyelid could be specifically activated. After exposure in air this fetus is reported to have made faint sounds (237, p. 754). This is probably the earliest observation of phonation in a human organism and has been referred to above.

In a fetus of the same length Bolaffio and Artom observe that every muscle reacts even to energetic stimulation, such as percussion, by local contractions. This specificity is more marked in the head than in the leg region of the fetus. Percussion in front of the ear led to a movement of closing of the eye with elevation of the angle of the mouth and chin. Strangely enough, however, it seems that the deep reflexes are not easily obtained in the upper limbs, but in the legs the patellar can be called forth bilaterally and the Achilles tendon reflex on one side. No plantar reflex can be elicited (29, p. 467).

In a fetus of 310 mm. Bolaffio and Artom further report the observation of periodic respiration which occurred by fits and starts, accompanied by regular heart beat. At this period every muscle of the limbs can be excited one by one with percussion, obtaining vivid reaction. Appropriate local stimulation serves to bring out most of the typical percussion reflexes, including minor responses of the fingers, of the toes, and of the sole of the foot. The plantar reflex, however, and some of the others still seem to be absent (29, p. 467).

These same investigators, using a slightly larger fetus of 330 mm., report that superficial respiratory movements appeared which again ceased after a minute or two, only to reappear with pressure and percussion of the thorax. In this fetus they note also that with percussion the muscles gave vivid localized contractions. The tendon reflexes which could be elicited included those of the biceps, triceps, and the Achilles reflex.

Direct stimulation of the cortex still brought no response. In this fetus they believe that no cutaneous reflexes could be called forth either before or after the removal of the brain. In another fetus of exactly the same size these same investigators report that "the fetus cries weakly and moves about spontaneously, but with less vivid movements than a fetus at term" (29, p. 468). When death seemed imminent in this fetus the top of the skull was removed and the cortex directly stimulated electrically. The various zones of the cerebral cortex were all stimulated with negative results. Stimulation of lower centers, however, led to specific results such as increased breathing rate, shoulder, arm, and finger movement.

Bolaffio and Artom also report the behavior of a fetus of 340 mm. which was slightly undernourished. This fetus made weak crying sounds and breathings. After about two hours it stopped breathing. During this period, however, they got contractions by tapping one by one the muscles and groups of muscles of the body. In this specimen by stroking the sole of the foot they got plantar flexion of the toes. All of these reactions became more vivid just before the death of the fetus (29, p. 469).

In a still larger fetus these two experimenters report that with slight percussion of all the muscles of the limbs they observed vivid responses not limited to single muscles. Such responses spread to synergic muscle groups. With percussion of the pectoral muscles they obtained adduction and internal rotation of the arm and flexion of the forearm. They obtained bilaterally the patellar reflex and an extension of the leg, sometimes associated with flexion of the thigh. Associated with this was the dorsal flexion of the foot. The Achilles reflexes, however, were not always obtained even in a fetus as old as this one. They also failed to get abdominal reflexes. However, the slight excitation of the sole called forth a definite unified toe phenomenon, and a more energetic stimulation called forth flexion of the toes. The sucking reflex was secured only by stimulating the tongue. They report that the movement of grasping which they got by applying pressure on the palm of the hand was energetic. These same investigators report that from the seventh month to birth they investigated thirteen fetuses of seven months, three of eight months, and a large number of mature fetuses. In this study they have not considered protocols from any fetuses which because of condition of nutrition or on account of the presence of disease did not present normal situations. They assert that from the end of the sixth month the movements of the fetus became so vivid as to render very difficult and sometimes impossible detailed and specific report of behavior (29, pp. 470-487).

The material presented above gives a picture of the development of behavior in human fetal material of known lengths. No effort has been made to include all known fetuses but only those in which behavior significant for the general problem of this paper was noted. Minkowski refers to at least eleven fetuses not considered here (238, pp. 486-489), in which primarily the reflexes to stimulation of the sole of the foot were noted.

In the study of this response Bersot (19, 20) has also considered fetal activity in great detail in relation to a study of the development of the clinically significant plantar reflex. This same response has been considered from a scientific and theoretical point of view by Feldman (119), also by Minkowski in work that has been referred to incidentally above (240). For an account of a fetus investigated by Winterstein, see (241, p. 517).

Turning now from the development of behavior in fetuses of known length, we must consider, for reasons suggested above, the development of behavior in relation to estimated age.

Behavioral Development According to Estimated Age. The germinal stage may be thought of as occurring during the first week or two of life. During this time rapid morphological development occurs. The details of this process are, because of the scarcity of human material at these ages, based mostly on the study of comparable types. For a brief review of this period of development the reader may well consult the excellent summary given by Williams (340, p. 163).

The third week is ordinarily thought of as the beginning of the true embryonic period. At this time the formation of the medullary groove has begun. A little after this the earliest form of the heart is laid down and the cerebral and optic vesicles begin to be differentiated. At the end of the third week, limb buds begin to appear and heart beat is for the first time noted. It is during this time, also, that the fine structure of the muscles continues to differentiate, as suggested above.

Second month. During the second month rapid morphological development occurs, both in regard to the gross outlines of structure and in regard to their fine histological make-up. For the most part it seems that the muscles of the human embryo cannot be directly stimulated, even by strong electric currents during part of this period, although of course the heart continues to beat. At about the end of this period, however, direct muscle contraction resulting from electric stimulation begins. In this period both Yanase and Strassmann report the first true fetal movements involving slow responses of trunk and limbs. As suggested above, great care must be exercised in interpreting these reports of early responses, because they are given by observers who have had less experience with fetal material, so far as their published reports indicate, than have the other investigators who report earliest movements at a somewhat later period. There seems to be no question about the fact, however, that at this period direct muscle stimulation leads to response. Bolaffio and Artom have even found this to be the case in isolated limbs torn from the fetus by the delivery forceps (29, p. 472). At the end of this period direct stimulation of the sole of the foot leads to contraction of the muscles of the foot. This response is possibly a direct result of muscle stimulation and independent of nervous control. Minkowski reports at the end of the second month the onset of response to cutaneous stimulation (234, p. 1202). This finding was not confirmed by Bolaffio and Artom (29, p. 473). They point

out that the skin at this time is very thin and that it is hard to be sure that alleged cutaneous stimulation does not really involve the deep stimulation of the underlying musculature. Indeed, it is possible that here, as in the studies of the cat fetuses by Windle and Griffin, an effort may expediently be made to differentiate between primitive tactile sensitivity involving both deep and light pressure and later specific tactile sensitivity in which the special skin senses have become better organized. The importance of this problem will be referred to below when the fetal senses are considered in detail.

Third month. During the third month Minkowski reports labyrinthine reflexes (241, p. 565; 237, p. 724), but Bolaffio and Artom, securing the same responses that Minkowski reports, interpret them rather as responses elicited as the result of the stimulation of proprioceptors in the neck (29, p. 471). Minkowski also reports tendon reflexes at this age (237, p. 723), but again Bolaffio and Artom do not find them until the sixth month (29, p. 473). Here once more the decision must be a very difficult one to make, if the present writer may judge from his own observations on infrahuman fetuses. Stimulation at the locus of a tendon may lead to a response, but this may be due to several possible forms of stimuli, such as (*a*) cutaneous stimulation, (*b*) direct muscle stimulation, or (*c*) to a true tendon-stretch muscle stimulus. Mere observation of the response makes very difficult the decision as to which of these forms of stimulation has been effective. Bolaffio and Artom's careful work, however, seems to indicate that at first muscle sensitivity dominates when the tendons are stimulated, but in later fetuses gradually true tendon reflexes begin to arise.

It is generally assumed that during this month the cerebral cortex has as yet assumed no functions in relation to the general bodily activity. Bolaffio and Artom, however, report that removal of the cortex in a fetus of this age seems to remove inhibition from the reflexes of the lower limbs. This result is difficult for the present writer to interpret. During this period sucking is theoretically possible; that is, the neuromuscular mechanisms necessary to bring about this response have probably already been determined. The reader who wishes a complete consideration of this earliest feeding reaction of the human individual should read the specific references given above to this reaction and then should refer to the summary of the knowledge of the reaction given by Feldman (119, pp. 448-455). [Cf. also (164).]

Fourth month. In fetuses of the later third or early fourth month, stimulation of the sole of the foot is found to evoke a response of the toes. In this response extension seems to dominate over flexion. The assembling of evidence from several available sources leads Minkowski to the conclusion that at this period the plantar reflex is to be considered as spinal (238, p. 484).

During this month the various observers report a general increase in the specificity of responses and also an increase in the intensity of actions

which result from stimulation. The various reflexes begin to take on a more precise form during this period. Stimulation of the sole of the foot comes to be differentiated in that the big toe no longer responds as do the other digits. This is sometimes spoken of as the onset of the Babinski reflex. During this period the sole-of-the-foot reflexes are thought of by Minkowski as having their connection centers in the spinal cord and in the tegmentum (241, p. 551). Bolaffio and Artom do not find a true Babinski reflex at this period, as noted above.

Fifth month. In fetuses of this age direct stimulation of the cortex still leads to no response (29, p. 477). Stimulation of the medulla, on the contrary, is found during this month to lead to a change in heart beat, energetic chest movements involving the cooperation of the diaphragm, and thoracic, abdominal, neck, and head muscles (29, p. 478).

Sixth month. In the sixth month there is an increased tendency of various receptor-neuro-muscular mechanisms to act independently, and this independent contraction is part of the greater vividness of response which characterizes this period as contrasted with earlier periods. Bolaffio and Artom in this month for the first time find tendon reflexes which seem to be assuredly not the result of cutaneous or muscle stimulation. Their judgment on this matter is based on the facts that the specific responses given at this period are not found before this period, but they continue to increase in strength during the later fetal periods, and that they are the same responses which are elicited in early infancy as true tendon reflexes (29, p. 472). Direct stimulation of the mouth and tongue at this age elicited the sucking reflex, according to Bolaffio and Artom. In older fetuses stimulation of the lips alone leads to sucking movements which may or may not be accompanied by the protrusion of the tongue (29, p. 477). As noted above, Minkowski found this reflex at an earlier period.

Seventh month. Certain responses noted in this month, while definite, nevertheless are seen to involve synergic muscle groups (29, p. 481). This finding must be taken into consideration in evaluating statements given in regard to the randomness of activity in the newborn child. It may well be that much of the apparent "mass activity" of the newborn child (167) is not truly diffuse response of the sort found in the early fetus, but rather the activation of groups of synergic muscles in the sense of the term as used by Sherrington and his associates (95, p. 129). Krabbe, Minkowski, and Bolaffio and Artom all report abdominal reflexes at this period. A number of other specific reflexes are also clearly brought out at this time. The knee-jerk is definitely elicited. The plantar reflex, according to Minkowski, now probably involves not only the centers concerned during previous months, but also part of the lenticular nucleus and the red nucleus. Bolaffio and Artom feel that at this period the plantar reflex in its typical form is much like that of adult life, but that it is still much more variable than it will be at a later period. This leads them to be critical of statistical work on reflexes, such as that of De

Angelis (100). [Cf. also (53).] The corneal reflexes are seen in this month. Direct stimulation of the cornea of the eye leads from this time on to an increasingly strong response. Decerebration in this month was found to lead to increased vividness of most reflexes, but also to a tendency to reflex spread.

Eighth and ninth months. During the last months of pregnancy the muscular reflexes decreasingly tend to prevail over the tendon reflexes, according to Bolaffio and Artom (29, p. 472). By the end of the ninth month the tendon reflexes are so well established that they prevail over special muscular reflexes. All of the tendon reflexes are found to be present during this period of fetal life, with the exception of those of certain of the upper limbs which are elicited with difficulty because of the small size of the member. Contralateral adductor reflexes are sometimes called out in this period. Even in the fetuses nearest term, the cremasteric reflex was difficult to elicit (29, p. 474).

At any prenatal age, including this last period, however, it is noticed that very light stimulation of the hand gives variable and inconstant movements, while strong stimulation, possibly involving the muscle or other underlying tissue, leads uniformly to grasping (29, p. 476). Bolaffio and Artom, therefore, believe that the grasping reflex is not to be thought of as a purely cutaneous reflex in prenatal life. Minkowski finds this reflex at an earlier period (241, p. 545). Iris reflexes are present during the prenatal period (29, p. 477). The reaction of the iris, however, is slow, and very strong light is needed to call out the response. [See also (241, p. 558).] It is difficult to say when the response would begin if stimuli as strong as direct sunlight could always be used. Bolaffio and Artom do not note the fact, but it seems obvious that with such strong stimulation as that which they recommend the danger of independent muscle effector action of the sort described by Parker (259, p. 53) must be guarded against.

There is some evidence that the cerebral cortex is directly stimulable at this period, although as yet the evidence is not conclusive (29, p. 480), as will be pointed out below in considering the possibility of fetal learning.

It is possible to add to this consideration of fetal development month by month, therefore, some general statements that have been made by those who have been most directly concerned in these investigations. Thus Minkowski holds that one may say that every part of the skin can, as its receptivity is progressively established, serve as a reflexogenous zone for quite variable reactions which tend to spread more or less over the whole fetal organism. In the whole developmental process the gradual acquisition of postural responses and muscle tone is peculiarly important. The development of these responses will be considered below in the section in which the origin and development of the proprioceptive and static senses are considered. Minkowski offers as in part explanation of the spread of reflexes during the early periods the fact that the spinal-cord tracts as well as the nerve trunks have no medullary sheaths before the fourth

month of fetal life. Figures of Minkowski's anatomical work on the nervous system are given in several places (236, 241). There is a suggestion that from this time onward there is an anatomical increase in specificity correlated with the differentiation of the nervous elements in ways possibly involving the nature of protoplasm, neurofibrils, medullary sheaths, synapses, long conduction paths, and other cell changes (237, p. 753). These gradual alterations in the nervous system, it is suggested, progressively lead to the possibility of more and more circumscribed and definite response. Compared with the diffuse character of early fetal response, therefore, in the late fetus Minkowski feels that all of the well-known special reflexes have more or less been established (233). The discussion above, however, has shown that the process of development of these reflexes is a complex one and later in adult life injury to the nervous system may bring about reactions which were characteristic of a previous period, even of a fetal period (237, p. 754). For the historical breaking of ground in this connection, see Jackson's essay on the evolution and dissolution of the nervous system (169).

It must have been impossible to read what has gone before in this paper without realizing that there is a general relationship in sequence of development of behavioral capacities from fish to man. It must be noted, however, that there are peculiar dangers in generalizing from, for example, the amphibian development of behavior, or even the rodent or cat development of behavior, to the growth of adaptive actions in man. For example, it has clearly been shown in the case of fish, amphibians, and lower mammals that the first responses involve a unilateral bending of the trunk. This stage may or may not exist in the human individual, but at any rate no observations have so far been made in which trunk movements unaccompanied by arm movements are observed in early fetuses. The basic pattern for the development of locomotion and other "individuated" responses, as suggested by Coghill and his students, may be seen in a less typical form in the case of human development than might be supposed, although Coghill himself has called attention to the attractive possibilities of the analogy (74, p. 1009). Little evidence of rhythm in the limbs of the human fetus has been determined. It may well be, therefore, that locomotor-like movements of the limbs do not appear until very late in the human fetal period. Windle and Griffin have summarized this comparative evidence, and they suggest that the movements observed in the kitten fetuses with which they have worked possibly should not be compared directly to human fetal movements because of the differences between the two in the type of adult locomotion. In a similar way the locomotor mechanisms in fish and amphibians which require a high degree of trunk-muscle integration may be difficult to compare with the conditions obtaining in a mammal that stands erect (346, p. 184). Such considerations as this bring up the old problem of the recapitulation in ontogeny of the phylogeny of behavior. This problem is as old as Aristotle (248, p. 69), and yet there seems to be nothing in the present evidence to make

this view seem anything but a generalized, and in many details an inaccurate, description, and certainly not an explanation, of development (see 99; 248, pp. 1632-1638).

Too much emphasis cannot be placed upon the fact that easy generalizations, such as the assertion that all behavioral development occurs from a generalized total pattern of the organism to the specific responses of adult life, must be taken with great caution. While this description may be true in many respects, particularly if the word "pattern" is given an unambiguous meaning, it seems certain on the basis of the specific responses considered above that it cannot be indiscriminately applied. Before generalizations can be made with assurance, there must be a large amount of accurate measurement and the determination of a series of statistical norms in regard to the development of each of the specific developmental stages in each form considered. Typical cross-sections in development in every form and in all responses from significant receptor surfaces must be considered before such a generalization can be made. Certainly the late fetus has an elaborately organized and in some respects quite specific response mechanism. To some stimuli the relatively early fetus makes quite definite responses. It seems hard to believe that anyone who knows anything of the structure and function of the tracts and centers of the central nervous system can read the report of fetal activity at various developmental levels given above and still feel that there is much to be gained by saying that before birth the organism reacts as a whole, as certain psychologists, possibly under the influence of a mistaken view of the *Gestalttheorie,* have recently suggested. Much of the nervous system may, in some sense, be involved in any partial activity of the system, but this does not mean that the system is not in many respects sharply differentiated. Certain essential relationships between diffuseness and specificity and between individuation and integration of behavior will become more clear after the parts played by the specific senses in fetal life have been considered.

VIII. The Special Senses in Human Prenatal Life

Historically there has been much speculation in regard to the rôle of the senses before birth. In earlier psychology these speculations largely centered about the question as to whether or not some sort of dim conscious awareness exists in the fetus before birth. More recently potentially experimental questions have been raised in regard to the possibility of the stimulus control of fetal behavior through the activation of the various receptor systems before birth. Objective techniques for the study of the senses in the premature or newborn infant have been devised, of which those of Canestrini (44) and Weiss (335) are significant examples. These techniques have not only made quantitative study of the senses possible in a new way but they have also added to the general knowledge of the part that stimulation plays in the subtle alterations of bodily activity. In this chapter, therefore, the various specific senses will be con-

sidered in turn in relation to fetal mental life when such mental life is considered as including not only experience but specific receptor-controlled behavior. After each sense has been treated, some generalizations will be drawn in regard to the significance for psychology of receptor-aroused activity in the fetus.

The Cutaneous Receptors. In a consideration of the senses of touch, an effort is made to suggest such differences as have been made in fetal life between light and deep pressure, temperature, and cutaneous pain. The development of skin in the human fetus has been anatomically described by a number of writers. This work is summarized by Feldman (118, pp. 233-236). In appearance the skin of the late fetus or an early premature infant is very red, due to the visibility of the vascular system just beneath it. At two or three months before birth the skin is still very thin and is covered with lanugo hairs, which appear at about the fifth month of pregnancy. The skin of the fetus during mid-pregnancy is typically much wrinkled, because of the comparative absence of the subcutaneous fat. The hair on the scalp at this same period is short and poorly pigmented. The nails grow gradually during late fetal life (146, pp. 74-77).

There has been much speculation historically on the skin as a sensory surface during the uterine life of the fetus. Cabanis is quoted by Genzmer as holding the skin to be a peculiarly important receptor field at this period (123, p. 10). Bichat and Magendie, as noted above, discussed the skin sensibility of the fetus (22, p. 137). Some casual observations are also reported in relation to the material summarized on a previous page of this chapter concerning the possibility of stimulating the fetus by pressing on the abdominal wall of the mother. Of course, stimulation of this sort may well activate the proprioceptors as well as the true tactile receptors. In the review of the literature in the experimental study of the development of fetal behavior in infrahuman organisms, many incidental references have been made to tactual stimulation. In the human field alone, Minkowski, Bolaffio and Artom, Krabbe, and others have considered fetal responses that are released by cutaneous stimulation as indicated above. The part of the sense of touch in animals and man in discrimination and even equilibrium is considered by Kidd (179).

A. Pressure. In summarizing the work that has been done on human and infrahuman fetuses, the following factors may possibly be isolated as important in a consideration of the pressure sense before birth:

1. *Place stimulated.* In general, cutaneous sensitivity seems to begin in the oral-nasal region, that is, the region involving the mucous membrane of the nostrils and the red of the lips (123, p. 6; 346, p. 179). In rodents the pads of the vibrissae also very early become sensitive (193, p. 34; 280; 52), and in many animals the regions about the eyes and the openings of the ears are also very early sensitive as is the anal region (88). In the human infant Kussmaul found the eyelashes very sensitive (192, p. 23), but this was not confirmed by Genzmer (123,

p. 6). Most studies seem to suggest that, with individual variations, skin sensitivity develops by spreading out over the head region and then progressively over the surface of the body. In this development in certain organisms, such as the toadfish, the salamander, the rat, and the cat, a fairly well-worked-out course of temporal difference in the arrival of sensitivity in increasingly caudal segments of the body may be made out. In animals with tails this even goes on out to the end of the tail. In this general course of development, however, certain exceptions have been made out and the present writer is finding others in the study he is at present carrying on in the development of the receptive zones of the fetal guinea pig. This sensory development has been treated by Minkowski and other investigators as the spreading of what they have termed reflexogenous zones. This term has been used because at present the only method used in the study of fetal sensory capacity on the skin is the recognition of behavior correlated with the experimental stimulation. Windle and Griffin suggest that motility precedes the ability of a part to be stimulated (346, p. 175). In his consideration of the "reflex circle" Holt has shown the large part that self-stimulation may well play in the development of specific forms of behavior (153, pp. 37-43). Certainly no one who has watched an active mammalian fetus can help being struck by the fact that in its own movements it stimulates almost its entire body surface. It is peculiarly striking to watch a forty-eight–day guinea-pig fetus, for example, stimulate its head and face by appropriately cupped "hands" not once but over and over again until it would seem that the surface must be irritated by the friction.

2. *Areal versus punctiform stimuli.* Minkowski (237, p. 723), Windle and Griffin (346, p. 175), Coronios (88), Raney (280), and the present writer (52) have all apparently noticed that stroking produces stimulation when single punctate stimulation does not bring about response. Following this suggestion, Raney has been able to show that stimulation of a point on the skin by a single hair may not bring about response, but stimulating the same area immediately around such a point with a brush made up of comparable hairs will sometimes bring about response. In this connection, see also Kuo (191, p. 507).

3. *Summation of stimuli.* The present writer and others have noted that a single touch with a light hair may fail to bring out response, but several touches at the same point may be effective in bringing out such a response (52).

4. *Weak and strong stimulation.* Genzmer long ago noted that entirely different responses might be elicited in a premature infant to weak and strong stimulation (123, p. 10). The distinction in terms of the strength of cutaneous pressure is one that has too infrequently been made in studies on fetal development. Thus, as noted above, Minkowski and Bolaffio and Artom disagree as to the point at which cutaneous reflexes begin in the developing fetus. This disagreement may be based on the fact that Bolaffio and Artom indicate the possibility that Minkowski was

unwittingly stimulating the underlying musculature and thus that the massive responses which he reports in young fetuses are not cutaneous but due to the stimulation of deep receptors (29, p. 473). Holt considers that the distinction between strong and weak stimulation is a peculiarly important one in the development of the functional activity of the growing organism. He believes that in most cases light stimulation will lead to response moving toward the stimulus or *adiently,* whereas only secondarily does strong stimulation of the same receptor field lead to *abient* or withdrawal and avoidance responses (153, pp. 40-43). Richter and others have confirmed this observation (282). Indeed, Coronios, Schlosberg, and the present writer have been able to take moving pictures showing exactly this response in the case of stimulating the paw of a fetal kitten (91). Under certain other circumstances, however, the results have not been such as to confirm absolutely this generalization. Thus Coghill asserts that the first responses of Amblystoma are all away from the region stimulated (76, p. 13). Windle and Griffin point out that the unilateral trunk or neck flexions of the earliest fetuses seem to be executed toward the observer and away from the surface on which the animal is resting (346, p. 175). Kuo also uses the strength of the stimulus as a peculiarly important part of the theory of development which he has recently proposed (191, p. 507). It seems possible that in responses in which apparently the same receptor field is stimulated first lightly and then more strongly two neural mechanisms may sometimes be brought into play. It might speculatively be suggested that the facts behind the differentiation between the allegedly developmental epicritic and protopathic sensitivity, as proposed by Head and Rivers, and especially as explained by Boring (31) and more recently by Sharpey-Schafer (291), will ultimately provide some clue in the explanation of this diversity of response to different stimulus intensity. Windle and Griffin also postulate a developmental system of cutaneous receptor mechanisms (346, p. 176). In any case, this difference in regard to the responses to tactile stimulation makes peculiarly uncertain the interpretation of results of investigators who do not indicate that they have considered the strength of the stimulus as important in describing the fetal responses which they have elicited in their experimental work. It is all the more peculiar that this distinction should not have been continuously made, because of the statement in regard to the difference in responses to weak and strong stimuli made, as noted above, many years ago by Genzmer.

5. *Localization.* Preyer believes that the first tactile localization is that developed in the infant in seeking the nipple by means of cutaneous stimulation of the lips (276, p. 110). A number of references have been given above to the motor responses of various fetuses set off by tactual stimulation. It has been suggested in connection with the work of Raney and the present writer that such responses possibly develop greater ability in accurate localization as development progresses.

6. *Cutaneous reflexes.* As suggested in the preceding points, the

skin may be thought of as the point of stimulation for more or less specific behavioral responses. Many writers have discussed the significance of cutaneous reflexes in adult life, and Givler has suggested the significance of the development of one such reflex (127). Minkowski, as noted above, considers in detail the variations in the form of the reflexes elicited by the stimulation of the skin of the sole of the foot. Sucking, while in its later stages possibly conditioned by a number of other exteroceptive and interoceptive stimuli, such as the stomach contraction of hunger, is in essentials always a cutaneous reflex. The cremasteric reflex and certain of the abdominal reflexes also involve stimulation of the cutaneous field. In general, then, it may be pointed out that many of the specific acts of the fetus are induced by stimulation of the cutaneous pressure receptors. Mucous-membrane reflexes (241, pp. 556-558) are also probably best thought of as involving receptor mechanisms, so far as pressure is concerned, that are similar to cutaneous reflexes. Peiper has recently tabulated the cutaneous responses seen in newborn children (268, p. 92).

B. Temperature. Warmth is one of the skin senses attributed by John Locke to the fetus (215, p. 62). It is difficult to understand, however, how marked differences in temperature can be present in prenatal life. In the case of the study of the temperature sense in the premature infant the matter is further complicated by the great variability of body temperature which characterizes the premature infant (146, p. 151; 116, pp. 11-15). Currently accepted views in regard to the nature of temperature stimulation start with the assumption that the temperature to which the skin is adapted must be taken as the zero point from which other stimuli are to be considered, and therefore quantified work in regard to temperature in the premature infant is rendered difficult. Some indications, however, of responses to warm and cool stimuli in premature infants are given by both Kussmaul (192, p. 23) and Genzmer (123, p. 11). For the most part these observations agree with those of the following observers on the temperature sense of newborn children: Preyer (276, pp. 111-116), Blanton (24), Peiper (268, pp. 28-29), and Canestrini (44, pp. 76-85). These opinions are criticized by Pratt, Nelson, and Sun, who also add their own controlled experimental observations (275, pp. 144-167). These three collaborators report that newborn infants react much less strongly to stimuli warmer than the body than to stimuli that are cooler. The writer is at present engaged in a study of fetal sensitivity in which some observations of the temperature responses of guinea pigs are being made. In this study unmistakable reactions to temperature both of warm and cool are secured under controlled conditions. Drops of blood-warm water call out no response, but cold- or hot-water drops do call out such activities. This sensitivity has appeared by approximately the middle of the gestation period.

C. Pain. Locke also attributed the experience of pain to the fetus (215, p. 62). Since his speculation there has been little direct experimentation upon the fetal pain sense. A number of casual observations show,

however, that the application of stimuli that must have caused gross destruction of skin and protoplasm have not called out very pronounced movements on the part of the fetus. Genzmer, on the basis of such observations, holds that pain is very little developed in the fetus. On the first day of a premature infant's neonatal life he stimulated it until blood came and got no response (123, p. 12). It is certainly true that increase in pressure over that necessary to bring out the typical responses to deep pressure does not always seem in the guinea-pig fetus, at any rate, to increase the extent or intensity of response. Thus in certain cases light pressure may lead to extension, strong pressure to retraction, but very strong and even destructive stimulation of the same point may or may not make any observable difference in the response over that noted to strong pressure stimulation with a stiff hair. Similar observations have been made on the cat fetus (346, p. 176). There can be no doubt that protoplasm-destroying stimuli bring about violent responses in late fetuses. Speculations on pain in relation to unpleasantness and discomfort will be referred to in the consideration of the organic senses.

There is thus much evidence that the specialized skin senses have developed before birth and are able by appropriate stimulation to initiate behavior that is sometimes rather precisely related to the point stimulated.

The Proprioceptive Senses. The neuromuscular spindles, typical proprioceptors, are found in the fourth month of fetal life in practically all muscles, including the extrinsic muscles of the tongue and the external eye muscles (113, p. 248). Historically it was not until quite recently that the kinaesthetic senses came to be surely distinguished from touch, as the present writer has pointed out elsewhere (48, pp. 204-209). Much that Bichat wrote about active touch of the fetus was possibly referring to the proprioceptive rather than the cutaneous stimulation (23). Kussmaul (192, p. 32) and Genzmer (123, p. 8) both refer to responses which must have involved muscle stimulation. Preyer makes similar references (277, p. 547). Peterson and Rainey also hold that not only touch but the activity of the muscles of the fetus must lay the foundation "under the threshold of consciousness for a sense of equilibrium and vague spatial relationships" (269, p. 122). In his study of the relationship between local reflexes and posture, Coghill comes to the conclusion that "the limb is able to respond very precisely to stimuli arising within the body (proprioceptive) as the result of a particular posture before it can respond to stimuli that arise exclusively from the outside world (exteroceptive)" (76, p. 21). In experimental work on operatively exposed human and infrahuman fetal material, the proprioceptive senses are much in evidence. Indeed, in the responses in fetal rats both Swenson (311) and Angulo y González (11) find evidence of this sense in a sixteen-day fetus. Coronios (89), and especially Windle and Griffin (346, p. 177), deal with this sense. As noted above in the consideration of the cutaneous senses, these investigators report activities that show that the posture of the cat fetus at the time of stimulation seems in certain cases to determine the response that will be

elicited. This point is not denied in any of the protocols of all the experimental studies of fetal behavior that the present writer has examined. It is possible that this fact indicates an early onset of proprioceptive control of behavior, or it may in some instances be a mere differential gravitational action on the limb and body even in water. In one of the studies of a very young human fetus—by Strassmann, noted above—it is recorded that the observer pressed against, in a manner which apparently means moved, the limb of the fetus, and that as a result of this stimulation the experimenter could feel the foot press down on his hand (305). The present writer has often noticed this same response in young guinea-pig fetuses. Even when light or relatively strong tactual stimulation would not release a response in the forelimb of the fetus, it has not infrequently occurred that a forcible moving of the limb gave a specific and direct response. As the skin is not anaesthetized in such a case, this may not of course be a wholly proprioceptive stimulus, but, as cutaneous stimulation was ineffective, the facts seem to favor the suggestion that it is proprioceptive.

There is still other evidence that the proprioceptors are effective very early in fetal development. Hooker and Nicholas have reported experiments on fetal rats in which the spinal cords have been completely sectioned at various levels (157). After some of these experiments it was found that stimulation above or below the sectioned point of the cord might lead to responses in parts of the body innervated by segments of the cord above or below the cut. The question at once arose—how were these impulses transmitted? As one of the possible explanations of this transmission, these investigators have suggested the following course of events. An exteroceptive stimulus leads to afferent conduction over peripheral nerves to the cord above the region of the section. From this still intact segment of the cord impulses pass out over efferent peripheral nerves to trunk muscles leading to this response. This response mechanically moves the adjoining musculature and thus directly stimulates the proprioceptors in it. These newly activated proprioceptors then initiate afferent impulses which pass into the cord below or above the region of the cut, as the case may be, and thus in turn activate arcs in the intact region of the cord above or below the section, which in turn lead to responses obviously initiated by the cord beyond the section. This is still a speculation, but it seems to be well founded (157, p. 449). [See also (155).]

Windle and Griffin report many evidences of movement that may be considered on the basis of the analysis of Sherrington and his students as at least in part proprioceptively innervated. Thus they report, and the present writer has seen and photographed similar responses, that a quiescent embryo held in the cramped condition of the sac will, on the cutting of the sac, sometimes at once assume an exaggeratedly stretched position as if to exercise himself after the close quarters of his entire previous existence (346, p. 186). This "extensor tonus" is in many respects similar to decerebrate rigidity seen in the adult animal and may well involve pro-

prioceptive stimulation. The experiments of Weed (331), Weed and Langworthy (334), and especially Langworthy (200, 201) give evidence in regard to reactions involving this receptor system. The present writer has sometimes noted when dealing with a late guinea-pig fetus that if the body weight of the fetus, still wholly immersed in the bath, is held by its forepaws on a submerged projection the animal will seem to try to crawl up on the projection using correlated movements which seem, to superficial observation, like those employed by a swimmer lifting himself out of the water onto a diving raft. This activity seems to involve complex proprioceptively induced responses. Most writers on the development of fetal behavior agree that locomotion, as, for example, in the first crawling movements of the fetal opossum considered above, sucking, and breathing are three of the earliest essential behavior systems of the newborn animal. It is interesting to note that each of these in its developed form involves marked proprioceptive activity. The geotropic responses of the opossum fetus considered above, occurring less than two weeks after copulation, seem, in the light of the work of Crozier (96, pp. 83-98) on geotropism in the rodent, to represent a response in which proprioceptive stimulation plays a part, although, as Hunter (161) has pointed out in a similar study, the vestibular apparatus and other factors are probably also important in determining this response in comparable types.

As noted above, Minkowski feels that there are true tendon reflexes in the early fetus (237, p. 723; 241, pp. 559-560). This is questioned, as noted above, by Bolaffio and Artom (29, p. 472), who suggest that the responses observed by Minkowski in very early fetuses may have been the result of other forms of stimulation. It may be pointed out, however, that the mechanism of deep stimulation which they suggest and true tendon-stretch stimulation involve proprioceptive activity. Indeed, it may be said that the whole study of prenatal behavior in man and in the lower mammals suggests that the proprioceptors in muscles and tendons, and possibly joint reactions, have begun well before birth and that by the time of birth they have undergone such development that they are among the best-organized receptor fields so far as the initiation and determination of behavior is concerned. Much of the "movement of the organism as a whole" may be the result of rather specific proprioceptive stimulation. Such stimulation often leads to the "spread" of what are really quite delicately timed responses which can easily be mistaken for "vague" or "diffuse" behavior.

The Receptors in the Non-auditory Labyrinth. Adult posture, righting responses, and other reactions to gravity, tonus changes due to rotation, and other alterations of the body in space are often held to result from stimulation of receptors in the non-auditory labyrinth and associated receptor fields (43, pp. 262-268). As suggested above in a consideration of the development of behavior in the fetal cat, the change of body posture in space has been shown sometimes to involve various combinations of non-auditory labyrinthine, kinaesthetic, and exteroceptive stimuli. In the

fetus it is peculiarly difficult to isolate the part played by the body exteroceptors and muscle proprioceptors from the part played by the receptors in the non-auditory labyrinth.

Historically, comparatively little reference has been made to the static senses in connection with fetal mental life as considered in the older speculative genetic psychology. Some reference has, however, been made to the part played by these receptors in determining the position of the fetus in relation to gravity. Lane has noted in his study of the development of the senses in the fetal rat considered above that there is an apparent correlation between the histological development of the semicircular canals and the acquisition of righting responses on the part of the fetus. In Lane's work, however, no effort to differentiate between proprioceptive and static stimuli is reported.

The development of the labyrinth has been considered by Streeter (306) and Larsell (203). [Cf. also Bowen (34).] Minkowski, as noted above, has demonstrated from neurological studies that the labyrinth is fully differentiated in a fetus of 40 mm. (237, p. 753). As noted above also, Windle and Griffin report that in very early cat embryos of twenty-six to twenty-seven days "rotation of head and trunk appeared to be indefinitely coordinated with the older components, namely, lateral and ventral head and trunk flexion. This activity resulted in motions that strikingly resembled the righting reflexes seen in late fetal life" (346, p. 156). Windle and Fish, however, later show that in cat fetuses several days before normal birth true labyrinthine reflexes appear (345, p. 95). These reactions make possible what has been called the first "purposeful" movement of the cat, that is, successful locomotion (346, p. 171). This complex behavior act, as already suggested, is held to be a combination of equilibration, the body-righting reflex, postural tonus, and rhythmic movement of the limbs.

Coronios and the present writer have both noticed that, in late cat or guinea-pig fetuses, turning the animal over while it is completely immersed in the warm bath does not always lead to righting movements. If the cord is ligated and the same fetus is placed on its side on the experimental table righting may at once begin. This is possibly to be interpreted as indicating that at this period righting still, at any rate, involves exteroceptive and proprioceptive as well as vestibular functions.

Similarly, with fetal material Coronios and the present writer have both been able to elicit typical Magnus reflexes of limb extension as the neck is turned to the right or the left. These responses are strikingly similar to those of decerebrate mammals and may tend to confirm the observation of many other investigators that for the most part the fetus is not under the active control of the cerebral hemispheres. Minkowski, at one time, reports labyrinthine reflexes in early human fetuses (237, p. 724). He suggests that it is not only possible to elicit responses from general labyrinthine stimulation, but that it is also possible to distinguish between the reflexes attributed by Magnus and his colleagues to the utriculus-sacculus

receptors as contrasted with those attributed to the semicircular-canal receptors (237, p. 724). His analysis leads him to believe that most of the fetal responses to non-auditory labyrinthine stimulation are the result of semicircular-canal receptor action (237, p. 724). Minkowski further states that in his opinion the early anatomical development and functional use of the vestibular apparatus in the fetus is probably related to the fact that the fetus is living in a fluid medium the specific gravity of which is almost equal to its own specific gravity. Therefore it is "weightless," a condition in which he believes the labyrinthine reflexes may be seen to operate to best advantage (237, p. 753). Minkowski is careful at another time, however, not to disregard the possibility that the phenomena noted as the basis for attributing labyrinthine function to the fetus may be the result of the stimulation of proprioceptors in the neck and related receptors (241, pp. 565-568). Magnus, in reviewing this work, seems to emphasize the part of the tonic neck reflexes in such activities (220, p. 113).

There is good reason to believe that the first eye movements of the fetus are in response to changes of the bodily position of the fetus in space; that is, the first eye movements are occasioned not by retinal stimulation, but as part of the general tonus changes of the body brought about by gross movements in space. This fact is brought out very clearly in Kuo's work (187, p. 426). Early eye-muscle movements, indeed, may be thought of as part of the generalized pattern of muscular movements out of which later specific movements of the body are said to be differentiated (239, p. 253; 241, p. 568; 322, p. 283). There is no reason to believe, however, that these early "postural" responses of the eye muscles are as definitely related to specific aspects of semicircular-canal stimulation as they are in the adult condition recently so well summarized by Favill (117), Maxwell (229), and Holsopple (152). Eye movements in adult life that are determined by vestibular function may be modified in various ways (109). But, so far as the present writer knows, no study has been made of the period when retinal stimulation is beginning to be effective in the eye-muscle responses previously related alone to general body posture.

In conclusion, in regard to the static senses in fetal life, the present writer can only reiterate the statement that it is difficult to say with assurance the exact part which these senses play before birth, but it is certain that the tonus adjustments of the body muscles in postural responses, including those of eye muscles, are among the most significant prenatal activities. An understanding of these responses is in many ways important in fetal and adult life (221). One of the most significant points, however, at which a knowledge of the development of proprioceptive responses in the fetus is important, is in the evaluation of the studies of postnatal life in which the alleged saltatoriness of certain responses there noted is observed in the light of the knowledge of prenatal postural responses. Popularly speaking, the postural actions of the fetus may be considered

as especially significant preparation for a great diversity of actions in postnatal life.

The Organic Senses. Historically there has been some speculation in regard to the organic senses in the fetus. Some have held that the fetus lives in a perfect world in which hunger, thirst, and all other needs are cared for before the need arises (22, p. 133). John Locke, on the contrary, holds that the unborn child has "perhaps some faint ideas of hunger and thirst" (215, p. 62). Kussmaul agrees with this view (192, p. 31). As noted above, Yanase has studied the movement of the fetal intestines, and in the rhythmic character of these movements is found a basis for possible organic experience and, indeed, for the indirect activation of the skeletal musculature (352, 353). The work of Patterson (265) and Carlson and Ginsburg (45) on newborn infants and on dogs delivered before normal time indicates something of the character of the tonus changes of the stomach which may occur in late fetal life. The tonus changes of the stomach in these organisms are found under appropriate conditions to be peculiarly rapid and active. This coincides with the observations of Preyer (278, pp. 152-158) and of Peterson and Rainey (269, p. 121) on the early hunger of the newborn full-time or premature infants. Some suggestion of the developmental course of hunger activities and stimulation may be secured from the observation of Hess that very early premature infants are much less able than later premature fetuses to show the usual signs of needing to be fed (146, pp. 177-180). Jensen notes the dependence of the reflex of sucking, too often considered merely tactual, on the concomitance of hunger stimuli and tactual stimuli in the infant (172, pp. 368-375). Preyer notes the whole sequence of bodily changes, even including those of the eye muscles which come to be related to the hunger activities of the newborn child (278, p. 153).

The theory of "drive" or motivation held by many modern comparative psychologists, which correlates such activities to some extent with organic stimulation, finds support in the observations of the random activity of the fetus which is shown by Irwin (164) and others to accompany hunger stimuli.

This concept of drive is closely related to phenomena considered by certain of the older descriptive psychologists as characterizing the motivating power of the affective processes of the bodily basis of pleasantness and unpleasantness. Thus Preyer and others have discussed pleasantnesss and unpleasantness as apparent before birth or immediately after birth (277, pp. 486-487; 276, pp. 140-176). These studies are based on unaided observation of facial expression and on instrumentally recorded bodily changes, such as breathing and directly measured cerebral volume (44). Facial expression is reported by Minkowski as beginning in the relatively early weeks of active fetal life, and so it seems that this possibility of expression has had ample opportunity of exercise during the prenatal period.

It should be noted in passing that the rate of fetal heart beat can be

modified by external stimulation, thus possibly leading to vascular stimuli of the sort often considered as falling under the heading of "organic experience." The possibility of respiratory experiences, or "feelings of suffocation" are certainly present, so far as may be judged from a knowledge of stimulation and response. But there is, of course, no evidence that any introspective state actually follows such stimulation. In conclusion, therefore, it may be said that there are possibly certain organic changes in the stomach, intestines, heart, vascular and respiratory systems which occur before birth which may be important in receptor stimulation. It is possible that the stimulation of these receptor systems may lead to fetal activity which does not, of course, have any specific external end in view until, as a result of external stimulation and learning, such stimulation in postnatal life comes to initiate adaptive responses which some wish to characterize as "end seeking." It may also be noted that no one who has worked with fetal material has failed to see that after repeated responses "fatigue" sets in and for a time stimulation is difficult or impossible (267). The question as to whether or not fetal quiescence is to be considered as fetal sleep has also been debated (277, p. 488).

Taste. The histological work on the development of the taste mechanism in the embryo is summarized in Keibel and Mall (176). Taste buds are said by Parker to begin to appear in man during the third fetal month. The taste receptors are also found to be much more widely distributed in fetal life than in adult life. Parker thus holds that there is evidence of a retraction of the sensory field in man from the late fetal period to the adult state. At first, taste buds are found on the tonsils, hard palate, and parts of the esophagus. Later functional taste cells are almost always limited to the tongue (260, p. 110).

Historically, there have been several different speculative opinions concerning this sense in prenatal life. The early opinions are summarized by Bichat (21, p. 136). It is undoubtedly true that the amniotic fluid might serve as a taste stimulus. But, as change is ordinarily thought of as essential to stimulation, the question may be debated as to whether or not change in the amniotic fluid as pregnancy progresses is enough to make it at any point a taste stimulus (118, p. 139). A safe conclusion seems to be that, although the mechanism for taste is present before birth, there is no adequate stimulation of this sense until after birth.

Experiments on the sense of taste in newborn children have been carried out by Kussmaul (192, pp. 16-21), Genzmer (123, p. 15), and Peterson and Rainey (269, p. 120), using the method of general observation of facial expression after stimulation. The conclusion of these writers is that sweet is distinguished, even by premature infants, from salt, sour, and bitter. It is difficult to be sure, however, that salt, sour, and bitter are stimuli for behavior that is specific. Canestrini (44) and Jensen (172) have worked out a method of experimentally recording bodily changes which result from taste. Pratt, Nelson, and Sun find that in the conditions of their experiment, involving very dilute concentrations, there

is not as strong evidence in regard to taste differentiation at birth as had previously been supposed. These later experimenters conclude that the real difference in the stimulating efficiency of various sapid substances in early life is not only quantitatively but qualitatively different from the condition in adult life (275, p. 124).

In conclusion, it may be said that the receptors for taste are probably not adequately activated before birth. The mechanism, however, has been shown, because of work on premature infants, to be ready to function in late fetal life whenever appropriate stimulating conditions are brought to bear upon it. Most experimenters seem to conclude that sweet stands in a class by itself so far as the infant is concerned. Salt, sour, and bitter are apparently distinguishable with greater difficulty. References to the sense of taste in infrahuman fetuses have been given above.

Smell. Bedford and Desse and others quoted by Parker (260, pp. 23-41) have considered the embryonic development of the receptor cells of the nervous fibers of the olfactory epithelium. Lane, as noted above, has studied the development of the olfactory structures in the rat (193, pp. 51-52). Feldman points out that the olfactory and tactual parts of the brain were found by Flechsig to be the earliest to be myelinated in the fetus (118, p. 237). Historically, save where taste and smell have been grouped together, there seems to have been general agreement, in the early period at least, that while the nasal cavity was filled by the amniotic liquid there could be no adequate olfactory stimulation. Preyer specifically defends this conclusion, basing his statement on Weber's (330) assertion that substances that could be smelled when vaporized were quite unable to arouse the sense of smell when introduced into the nose as liquids (277, p. 478).

A great deal of recent work critically summarized by Parker shows, however, that there is excellent reason to believe "that the olfactory organs of an air-inhabiting vertebrate can be stimulated by ordinary solutions, though this form of stimulation cannot be looked upon as normal" (260, p. 59). Even though this be the case, however, the same difficulty as that met with in the sense of taste must be considered. Even though the amniotic fluid may be an effective inadequate stimulus for the olfactory receptors, there is little reason to suppose that there would be sufficient change in the liquid to effect significant stimulation during prenatal life.

In this sense, therefore, the study of smell reactions of prematurely delivered infants will again be significant in showing how the functional development of the olfactory mechanism progresses during late fetal life. Kussmaul found that asafetida and certain other odors, but not irritating substances, led to responses in a one-month premature infant (192, p. 23). He is not sure that he was able to secure responses in earlier premature infants. Peterson and Rainey also found smell reactions in premature infants (269, p. 121).

Historically, there has long been a belief that the newborn child could

distinguish odors effectively. Feldman asserts that the Jewish sages in the time of the Talmud believed that a blind baby could tell his mother's milk by smell and taste (118, p. 237). Rousseau also commented on the sense of smell in newborn infants (118, p. 237). Preyer reports that an eighteen-day infant refused a breast-nipple on which kerosene had been placed, but eagerly took the other breast immediately after the refusal (276, p. 134). Preyer also demonstrated that newborn guinea pigs apparently select their food by the sense of smell. He held, moreover, that in young animals, including man, the sense of smell in general is most important in determining behavior (276, p. 134). Indeed, in infrahuman animals it is suggested that this significant aspect of behavior determination by smell does not come to be neglected to the extent that it is by civilized man.

The recent work on the sense of smell in newborn infants, which is probably also in general applicable to late premature infants, has been summarized by Peiper (268, p. 27), Pratt, Nelson, and Sun (275, p. 143), and by Canestrini (44, pp. 86-87). Canestrini concludes that there has been some exaggeration in regard to the effectiveness of the sense of smell in young animals. He feels that most of the work on smell has been concerned with stimuli which act on the trigeminal components of the nasal receptor surfaces (44, p. 95). These trigeminal components are probably best considered as the *common chemical sense* (260, pp. 103 f.) and not in the usual sense of the term "tactual" as suggested by Pratt, Nelson, and Sun (275, p. 127). Stimulation of the common chemical sense receptors typically sets off violent reactions, such as sneezing. A characteristic irritant of this sort is ammonia (260, p. 102). It is significant in this connection to notice that Pratt, Nelson, and Sun found ammonia to be a peculiarly effective "smell" stimulus (275, p. 143). Probably the responses of a newborn infant to ammonia should be considered as responses to the common chemical sense rather than to true olfactory stimulation.

In summary, it may be said that the neural mechanism for olfaction is developed before birth, and the possibility of inadequate stimulation exists before birth. It is probably true, however, that olfaction does not generally occur in its normal form until the nasal cavity comes to be filled with air. Premature infants, at least in the last month, are able to smell substances when air enters the olfactory cavity. Much work on smell, however, has probably been vitiated by the fact that the free nerve endings of the trigeminal nerve, the receptors for the common chemical sense of Parker, have been stimulated rather than the true olfactory spindles.

Hearing. Anatomically, the development of the ear in the individual has been extensively studied. This work is summarized in Keibel and Mall (176, pp. 264-290). Hess shows an original drawing of a section through the ear of a late fetus (146, p. 76).

Historical opinion in regard to the sense of hearing in the human

fetus is probably best summarized in the words of Kussmaul: *"Von allen Sinnen schlummert das Gehor am tiefsten"* (192, p. 27). The history of experiment on the sound response of full-term and prematurely born infants is excellently summarized by Pratt, Nelson, and Sun (275, pp. 78-85). The general conclusion of these authors themselves is in harmony with the later investigators that hearing becomes effective in the very early part of postnatal life.

Most of the early investigators on the development of audition concluded that the auditory mechanism was developed to a point at which it could be functional before birth, but that the infant remained deaf until by breathing, crying, and possibly yawning, the Eustachian tube was opened, and the somewhat gelatinous liquid of the fetal middle ear drained out (276, pp. 72-96). Peterson and Rainey specifically secured evidence of auditory response in a prematurely delivered infant as soon as there had been an opportunity for the draining of the middle ear (269, p. 118). More modern work seems to have offered no reason to differ with this conclusion so far as stimuli of normal intensity are concerned. Preyer also reports that newborn guinea pigs are deaf for one-half hour after birth and are then sensitive to tonal stimuli of a great variety of frequencies (C of third octave to E of the eighth) (276, p. 92). Avery has secured comparable results on late guinea-pig fetuses prematurely delivered, as noted above (13, p. 265).

While there has been some speculation on the fact that the sounds of the mother's body might act as sound stimuli to the fetus, little evidence has been brought forward to make this seem probable (277, p. 480). Recently, however, there have been two experimental findings which suggest that loud auditory stimuli may activate the fetus. Peiper was led to this study because he found that in six neonates, very soon after birth, changes in the breathing curve were found in response to a special sound stimulus (267, p. 237). The change in the breathing curve is reported as marked. He therefore decided to try to find out if any indication of hearing before birth could be secured. It had been discovered that auditory and other sudden stimuli give two sorts of responses in the newborn—one, a change in breathing rhythm, and the second, a change in the level of general movements. Peiper felt that there was no reason to believe that the unborn child should respond differently if it could be stimulated in its auditory receptors. The breathing center is open to stimulation before birth. He, therefore, thought of the possibility of using the prenatal "breathing movements" of Ahlfeld. The disadvantage was found, however, that these movements were not always present, and so the number of subjects was limited. But by proper recording apparatus he was able to take records of the general movement of the fetus through the body wall of the mother (267, p. 238). It was obvious that sounds would be much muffled on their way to the fetus. Therefore, a very loud sound was chosen as a stimulus, an automobile horn being used. The experimenter waited until the fetus was absolutely quiet, and after the mother

had been prepared so that she would not herself respond to the stimulus, something that proved impossible with some mothers, the stimulus was given. In more than a third of the subjects studied, definite reactions were secured to stimulation of this sort. There were individual differences in the responsiveness, however. Sometimes the response was given on one day and not on the next. The movements which the fetus gave to the stimuli were different. Most often, however, the child seemed to draw its whole body together. Peiper comments that it might seem to one who had not been present at the experiments that the movement was a response of the mother and not of the fetus. He is certain, however, that one who had actually observed the experiment would be convinced that the response was fetal and not maternal. As an additional safeguard in regard to this matter a pneumograph was placed on the mother's chest and her breathing curve taken during the experiment. After a good deal of practice it was possible to so train some mothers that they made practically no response, and thus the fetal response could be recorded. Continued stimulation led to a diminution of the effect. This corresponds to a frequently observed phenomenon of fetuses and neonates, namely, that their responses are easily fatigued or exhausted. Peiper even goes so far as to suggest that this change in response may be thought of as a simple kind of attention. He also notes that one mother remarked that she had noticed marked movements of the fetus while attending a concert (267, p. 239).

More recently Forbes and Forbes have reported a case of apparent fetal hearing (122, pp. 353-355). Thirty-one days before her baby was born a pregnant woman was lying in a metal bathtub full of warm water. A two-year-old child was playing on the floor beside the tub. Accidentally the child struck the side of the tub with a small glass jar. "Instantly a sudden jump of the fetus was felt by the mother, giving a sensation wholly unlike the usual kicks or limb movements." A few days later an observer struck the side of the tub below the water line a quick rap with a small metallic object, meanwhile watching the mother's abdomen. A fraction of a second after the rap, a single quick rise of the anterior abdominal wall was clearly visible. The mother at this moment felt the same jump inside her abdomen as previously reported. "Her own muscles were entirely relaxed at the time, and she was not at all startled at the noise, nor was she conscious of feeling any vibration through the skin." The mother's tactual sense later tested showed that the same intensity of vibration could be perceived only by those portions of the skin coming in contact with the tub. In this same infant, eight days after birth, it is interesting to note that while the baby was nursing an auditory stimulus occurred which resulted in the flattening of the baby's ear against the side of the head for a few seconds, after which the ear relaxed again. These same investigators also report another case in which concerts toward the end of pregnancy led to troublesome activity on the part of the fetus. The conclusion of these writers is that "good evidence exists that

the human fetus four or five weeks before birth can respond with sudden movements to a loud sound originating outside the body of the mother. It seems probable that this is a true auditory muscular reflex, but the possibility of reception through tactual organs in the skin cannot be excluded" (122, p. 355).

In summary, therefore, it may be said that the auditory mechanism seems to be well developed structurally during later fetal life, but in general, possibly because of the closure of the external ear or because of the gelatinous liquid which fills the middle ear, the fetus is probably deaf to sounds of normal intensity before birth and during a short period immediately after birth. Strong sounds, however, possibly those which can directly pass through these mechanical blocks, seem to be able to bring about auditory stimulation before birth, although it is still possible that such responses are tactual rather than truly auditory.

Vision. The specific morphological changes which are essential antecedents to the development of the function of the human eye begin in the second or third week of development of the embryonic period, and from that time on an elaborate series of events occur until in the normal human individual binocular convergence and the elaborate activities associated with visual space perception develop in the young child. The anatomical aspects of this growth have been summarized by Keibel and Mall (176, pp. 218-258) and by Mann (226). Hess has described in some detail the eye of an early premature infant (146, p. 75).

So far as the function of sight in prenatal life is concerned, there has been general agreement that the absence of radiation of the sort that typically activates the retina makes true sight impossible in prenatal life (277, p. 483). There is evidence, however, in Kussmaul that pronounced differences between light and dark bring about specific reactions in an infant born two months before term (192, p. 26). Peterson and Rainey also found light reactions in premature infants (269, p. 118). Genzmer does not confirm this observation (123, p. 21). Preyer agrees that adequate stimuli were impossible during fetal life, but he considers the possibility that inadequate stimuli of pressure similar to the stimuli which bring about phosphenes might be effective in prenatal life (277, p. 485).

There is evidence that even at normal birth the optic nerve and related structures have not fully developed (275, pp. 44-51). This knowledge has led to speculation in regard to the neural basis of the development of eye-muscle function in neonatal life. This whole question has been considered by Preyer in relation to the nativistic and empiricistic theory of the visual spatial world, with the conclusion that the evidence is conflicting (276, p. 71).

One of the best indices of the sensitivity of the fetus to light, although possibly not to the full neural mechanism involved in true visual responses, is thought to be the onset of the pupillary reflex. In 1818 Portal (274) alleged that responses of the iris diaphragm did not appear during fetal

life. Hess and others, however, have recently shown that in premature infants strong light stimulus leads to contraction of the pupil, followed in two or three seconds by dilation again (146, p. 75). Bolaffio and Artom (29, p. 476) and Minkowski (241, p. 558), as noted above, have been unable to make unequivocal statements about light reflexes in late fetuses. As pointed out in another part of this chapter, care must be exercised, especially when strong light is used, not to confuse the independent non-neurally determined muscular response of the iris to light with the true iris reflex. The development of the pupillary response in postnatal life has been summarized by Peiper (268, pp. 11-13).

The evidence in regard to the general muscular movements of the eyes in the first days of life has been summarized by Pratt, Nelson, and Sun (275, pp. 44 f.). The early eye movements have been carefully studied in the newborn child by Sherman and Sherman (292). As already noted above, however, there is excellent evidence to show that during fetal life eye movements occur as part of the general tonus change of the body musculature resulting from spatial reorientation of the entire fetal body. Preyer (276) and many students since his time have discussed the development of function in the auxiliary musculature of the eye, including the mechanism of winking. In general, great differences are noted in the tonus and general behavior of the lids in the newborn child as contrasted with the older child. Some hints of the beginning of this development are to be found in the reports on fetal development given by Minkowski. In a fetus of only 160 mm. he found that touching the closed eyelid led to a contraction of the orbicularis muscle (237, p. 723).

So far as infrahuman organisms are concerned there is the greatest divergence from type to type in respect to the time of the opening of eyes. The subject has early been investigated, Emmert (114), one of the first students of fetal mammals, having studied this phenomenon in the mouse. Certainly no generalizations can be made from form to form in regard to eyelid activities at the time of birth. The guinea pig is born with eyes open and apparently in an adult functional condition, whereas the lids of the rats do not gain their adult condition until the sixteenth or seventeenth postnatal day (193, p. 69). The study of this eyelid mechanism has presented evidence on the neural basis of behavior, as will be noted below.

In conclusion, it can be said that the specific morphological changes that lie behind the development of the visual mechanism occur from possibly the second week after fertilization until well after birth. Light stimuli ordinarily do not affect the retina before birth, but in the case of premature infants it can be shown that the eye is probably sufficiently structurally developed before birth to make possible the light or iris reflex and the differentiation between light and dark. The development of the muscular apparatus of the eye is also gradual. Indications have been secured in regard to the relationship between the vestibular stimulation and eye movements before birth. Eyelid reactions are also found to have undergone a progressive series of changes before birth occurs.

IX. The Senses in General Relationship to the Onset of Mental Life in the Prenatal Period

The Senses in General. For the psychologist there seem to be two major problems connected with the study of the senses. The first of these is the classic problem of the relationship between the senses and introspective experience. The second is the relationship between the receptors and the initiation, modification, and control of behavior. Many psychologists, on the basis of excellent reasons, hold that ultimately these two problems reduce to one, as Langfeld (196) has recently shown in his interpretation of consciousness in terms of response. Historically, however, and indeed at the present time, the two problems are usually treated as separate, or at any rate as separable, aspects of the total functional description of the psychological aspects of the relationship between the organism and its environment. Therefore, without attempting an ultimate answer to the question as to whether these two problems are really one, they here will be treated as independent.

A study of the fetal senses contributes little to our knowledge of introspective psychology. There has been much speculation concerning sensory experience before birth, but little of scientific validity has been written. As incidentally noted above, several of the empiricistic philosophers concerned themselves with prenatal life. Locke did not neglect the possibility that some dim ideas were present before birth (215, p. 62). Cabanis held that quite elaborate sensory experiences were present in the fetus, even to the consciousness of self (cf. 85, p. 40). Kussmaul held that the child came into the world with a dim perception of an outer world (192, p. 36). Preyer also attributed experience of a sort to the fetus (276, p. 177). Peterson and Rainey say, "The new-born comes into the world with a small store of experience and associated feelings and a shadowy consciousness" (269, p. 121).

Such observations could be added to almost endlesslv, but on the whole they seem profitless. Compayré, almost forty years ago, summarized the scientific arguments against such speculations as well as against the fancies of the Neo-Platonists that "our birth is but a sleep and a forgetting." The gist of this argument is that there can be no evidence on the matter (85, p. 44).

James, and more recently Koffka and his associates, have made much of the fact that in early postnatal life specific experiences like specific acts of behavior become individuated out of totalities rather than at first synthesized out of discrete elements. Thus James says: "The baby assailed by eyes, ears, nose, skin, and entrails at once, feels it all as one great blooming, buzzing confusion." And again, "Our original sensible totals are, on the one hand, subdivided by discriminative attention and on the other united with other totals" (170, Vol. I, pp. 488-489). Koffka similarly asserts, "From an unlimited and ill-defined background there has arisen a limited and somewhat definite phenomenon, a quality" (184, p.

131). Certainly if this description be adequate to the experiential life of the neonate, there is no reason to suppose that it may not also be adequate, although possibly in a still vaguer form, to experiential fetal life. If the present writer were asked to make a guess in regard to the matter, he would say that he feels that the description given above by Koffka is probably relatively adequate as a description of the facts of the development of fetal conscious experience. It must be noted, however, that, so far as the present writer is able to determine, there is absolutely no way to prove or disprove such a surmise. Essentially, the difficulty with such speculations is that they require the inference of consciousness of a particular sort from the external observation of the structure and function of organisms quite unable themselves to give linguistic introspective reports. The general method of introspection as a scientific tool has been severely criticized during recent years, and certainly if the general method is open to objections the method of indirect introspection is even more vulnerable. As Washburn, one of the ablest exponents of the use of indirect introspection in phylogenetic psychology, says:

> "We know not where consciousness begins in the animal world. We know where it surely resides—in ourselves; we know where it exists beyond a reasonable doubt—in those animals of structure resembling ourselves which rapidly adapt themselves to the lessons of experience. Beyond this point, for all we know, it may exist in simpler and simpler forms until we reach the very lowest of living beings" (328, p. 33).

So far as the present writer is concerned, he sees no objection to applying to ontogeny a similar point of view to that expressed above in regard to the interpretation of consciousness in the development of the race. He feels certain, however, that such considerations should be treated as inferences and not as facts of observation.

The second large problem which concerns the psychologist in relation to receptor activity has grown out of the approach to the study of mental life which deals explicitly with the processes of behavior. The problem of the receptor, or, possibly better, of stimulus control of behavior is, however, much older than self-conscious *behaviorism*. Kussmaul, indeed, explicitly defended this view in undertaking his study of premature and normal newborn infants (192, p. 6). It is indeed related to a much more general position as in the view expressed by Forel and quoted by Canestrini, *"Das wahre Baumateriel der Organismen liefern die Reize der Aussenwelt"* (44, p. 100).

It certainly seems more and more certain that, whatever else scientific psychology must do, it must concern itself increasingly with the relationship between the environment external to the receptors, be they exteroceptors, interoceptors, or proprioceptors, and to the responses of the organism to such stimulation. Therefore, in any consideration of fetal psychology especial attention must be given to the facts of the stimulus control of behavior. In order to understand this relationship, it will be

necessary to review the current status of fact and theory in regard to the causes underlying the beginning and differentiation of activity in the fetal organism. This consideration may well be considered as a conclusion to the present chapter, because any such discussion will necessarily involve a review of many of those processes of fetal life which are even inferentially significant for general psychology.

In the beginning of this chapter, something was said of the early processes of morphogenesis in the developing organism. It was suggested that the point to be kept continually in view by one who is interested in behavioral development is that the general growth of structure and function always occurs in an organism in an environment. From the first cell division in the developing individual, each process of structural and functional modification is, moreover, to be considered as a complex resultant of activities. Some of these determinants are intrinsic in the cell and are, indeed, in the correct sense of the term hereditary, but such intrinsic determinants always act in a dynamic system which is also subjected to extrinsic influences. Development is apparently a resultant of these two sets of forces *interdependently* working. For some of the evidence in regard to this matter, see an earlier paper by the present writer (46). L. W. Sharp summarizes this point of view when he says in his consideration of general cytology:

> ". . . The cell should not be thought of as a static thing with a permanent physical structure. It is rather a dynamic system in a constantly changing state of molecular flux, its constitution at any given moment being dependent upon antecedent states and upon environmental conditions" (290, p. 58).

If space permitted a review of the present status of that part of scientific embryology which is devoted to developmental mechanics, it would become apparent that the process of growth in the organism involves a most complex series of energy relationships, some of which, it seems probable, have as yet only begun to be unraveled. It is certainly true, however, that, at least since the work in the latter part of the last century by Roux, the older static view of development based on the study of dead histological material has gradually given way to the modern notion of an *Entwicklungsmechanik* (286). For an evaluation of this change, consult Morgan (246) and Holt (153, pp. 8-23). As suggested above in regard to the cell, this study has shown that the process of development in one sense, at any rate, must apparently be considered as a dynamic organization of a system of energies. This view of the development of an active organism makes it apparent that growth is not to be thought of as a mere unfolding of preformed materials, but rather as the construction of a new pattern of organized systems and subsystems in protoplasm. Each such system is to be understood only in its particular environment. As Dürken has well said: *"Die Entwicklung ist keine einfache Entfaltung, sondern eine wirkliche Neubildung . . ."* And again: *"Kurz gesagt, ist daher an der Allgemeingültigkeit des epigenetischen Charakters des Entwicklungsprozesses*

nicht zu zweifeln" (112, pp. 109-113). Many similar statements, and the elaborate evidence upon which they are based, could be found in the rich experimental work of the modern students of developmental mechanics. In such a view, however, it is of course possible, starting with the energy relationships between the organism and its environment, to go beyond the established facts. Whether or not this has been done by Child, it would be a presumption for the present writer to say. The following quotation from that student of the physiological development of the nervous system, however, indicates that it is possible for an experimental biologist to consider the external energy relationships of the organism as of the greatest significance in determining development. Child makes this very definite when he says:

> "The organism represents an order and unity in protoplasm which is related at every point to the external world. The development and evolution of organismic integration are essentially the evolution of mechanisms and methods of response and adjustment to environmental conditions" (54, p. 7).

This investigator has developed, on the basis of much experimental work, a concept of various sorts of gradients in the living and developing organism. In certain respects these gradients may in the last analysis be thought of as energy relationships, which are embryologically often precursors of definite organ systems. In so far as the nervous system is concerned, he says:

> ". . . the reflex strictly speaking is a specialized behavior pattern depending on the presence of certain morphological mechanisms; but it is physiologically a development from the primary organismic behavior mechanism, the excitation gradient" (55, p. 235).

It may well be, of course, that the relationships between the series of events occurring in the organism and the series of events occurring outside the organism are more elaborate than would be suggested by a relationship "at every point"; that is, that some such view as the "organizer" of Spemann (299), if the present writer correctly understands it, may supplement the simple intrinsic-extrinsic relationship by what may be essentially a chemical process or other process occurring in time and intrinsic in the organism. However, whatever the details of this development may be, it seems relatively sure, as the work of many investigators seems to demonstrate, that there is, antecedent to the possibility of functional action in the differentiated nervous system, an elaborate series of processes in the organism, some of which involve what are, to the elements of the system, environmental forces. An hypothesis concerning the relationship between a primitive gradient of activity and the beginning and development of true nervous structures and functions has been made especially clear by Coghill (76, pp. 39-78). This point of view emphasizes, as Burnham (40) has well pointed out, that environmental stimulation which is basic in an understanding of adult psychological phenomena is itself in certain

respects, at any rate, significant in determining the mechanisms which make such adult responses possible. In this connection the work of Kappers (174) and Bok (28) on the functional activity of neuroblasts in the development of the elements and the relationships of the central nervous system may be mentioned. The theory of neurobiotaxis developed by these writers, which suggests that the growth and arrangements of the nervous elements are tropistically determined responses of the elements of the nervous system, has proved to be a valuable hypothesis in the experimental embryology of the nervous system. The contributions of Ingvar (163) and others to this point of view are summarized by Herrick (142, pp. 111-112) and Child (54). The brilliant work of Detwiler (104-108) and other experimental embryologists on the morphology and energetics of neural development also presents specific evidence in regard to the relationship between external and intrinsic factors in the development of the functional nervous system.

There seems, therefore, to be excellent evidence for the view elsewhere discussed by the present writer (46) at greater length that, from the moment that growth has begun in the fertilized ovum until senescence or death, development consists in the alteration of existing structures and functions in an organism living in a continually changing environment. That is, it is not possible save for pragmatic reasons to say at any point that growth has stopped and learning has begun, but that the environment plays a part in all "maturation," and maturation plays a part in all learning. The course of this development, however, is apparently almost infinitely complex. It cannot be summarized by any catch-word phrase. But it does seem that the suggestion made in the introduction to this chapter that even the first receptor-neuro-muscular response of the organism is not to be considered in all respects a novel event follows directly from the knowledge that the organism develops in relation to an environment of energies. The processes which have gone on in the organism in order that the first response can occur apparently themselves involve elaborate stimulus-response relationships in narrower environments. Thorndike has recently picturesquely said that the life processes of a neuron include (*a*) eating, (*b*) excreting waste, (*c*) growing, (*d*) being sensitive, conducting, and discharging, and (*e*) movement. "The neuron thus lives much as would an amoeba or paramecium which had been differentiated to make conduction its special trade and which had become fixed immovably save for a few extremities here and there" (316, p. 57). A similar portrait could be drawn of the other cells of the developing response mechanism. Thus it seems probable that the first activity of the total arc is both old and new. The processes that are involved are similar to the processes of its growth in certain respects, but when it acts as a totality new time relations, if not new polarities, are involved. Thus an "organismic" response emerges from more primitive activities. But the function is to be understood completely only if described in terms of the past history of the mechanism concerned and of the present stimulating situation.

This distinction between part and total function is clearly illustrated in the known facts of peripheral nerve regeneration. Sherrington (293) points out that, when a previously cut nerve is regenerated, what is developed in the nerve, so far as the adaptive function of the total arc is concerned, is useless until total regeneration and end-organ attachment is completed. But, of course, the processes of development are themselves functions of the environment of the regenerating cells. Thus the eventual emergence of the so-called property of total arc-conduction is in one sense not a saltatory change. So far as the functions of the protoplasmic patterns are concerned it may be said that they involve merely a novel temporal and spatial organization of processes that have occurred in other energy relationships during previously described stages. For a suggestion of some of the factors involved in such development, see Goldstein (130).

It seems to the present writer, therefore, that the fact that cells and tissues do not develop in isolation, as Irwin points out in an excellent recent summary of the so-called *organismic hypothesis* of development, does not necessarily mean, as this same writer asserts in another place, that the "nervous system is a complex dynamic organization which operates as a whole" (166, p. 194). On the contrary, it seems to suggest that the story of the development of behavior must be written not in generalized formulas, but in terms of the accounts of the development of specific processes, no matter how diffuse, occurring in particular organisms under definitely described environmental conditions.

The discussion of the last few paragraphs has been necessary to prepare the reader for the consideration of the psychological aspects of the stimulus control of behavior. In the course of the study of the onset of receptor-neuro-effector behavior many suggestions have been made in regard to the cause of these first acts. The present writer can see no reason to believe that all of the diverse causal factors suggested are necessarily mutually contradictory, in spite of the many assertions to that effect. Indeed, it seems that so far as the onset of behavior in the fetus is concerned, *the fallacy of the single cause* has been peculiarly in evidence. As Jennings well says:

> "This fallacy is the commonest error of science, making unsound a considerable proportion of its conclusions. Everywhere there is a search for 'the' cause of this or that phenomenon; the investigator is not content until he has found 'it.' Yet natural phenomena—and most emphatically is this true of biological phenomena—merely arise out of the complex situation in which they occur. Many elements of that situation affect them; and all that experimental science can do is to determine what difference is made by altering one or more of these elements; none is 'the' cause to the exclusion of the others" (171, p. 208).

In this chapter, therefore, an effort will be made to summarize some of the scientific facts and some of the theories which relate to the onset and development of early behavioral capacities of the organism. No attempt

will be made to arrive at one single conclusion, unless that conclusion be that the onset of behavior is a most complexly determined fact.

Certainly most fundamental in the writings of most students who have concerned themselves with early development of behavior is the view that the nervous system is somehow basic to the observed responses of the organism. As we have seen above, this view was probably implicit in Dante's speculation in regard to the onset of behavior in the fetus. Indeed, it might probably be truly said that each advance in the knowledge of the true function of some part of the nervous system has indirectly influenced the thought of those who are concerned with the early onset or development of the function in question. The details of the specific neural changes necessary for the onset and development of behavior have, however, been diversely dealt with. Thus, some students, such as Coghill, although not wholly neglecting other factors emphasize above all else the anatomical relationships in the nervous system of the organisms under consideration. The following quotation from Coghill in regard to the neural basis of behavior in Amblystoma may be considered as typical of this tendency and also gives a fair picture of what is at once one of the simplest and one of the most adequately studied neural mechanisms subtending behavior:

> "There are therefore in this non-motile *Amblystoma* both sensory and motor nerves in contact with their respective organs, the sensory field on the one hand and the muscles on the other, but the anatomical relations between these systems are such that an excitation can not pass from the sensory to the motor mechanism. The muscles, while contracting in response to a mechanical stimulus applied directly to them, do not respond to stimuli from the skin, either tactile or chemical. Even when dropped into slowly-acting fixing solution, embryos of this state do not give any evidence of muscular excitation.
>
> "With the ability to respond to tactile or chemical stimulation of the skin there appears a third series of cells. They bridge the gap between the sensory system of one side and the motor system of the other. . . . Their bodies lie in the floor plate of the medulla oblongata and upper part of the spinal cord . . . In the non-motile stage these cells are unipolar. The one pole of the cell extends either to the right or to the left into close relation with the motor tract on one side only. When they become bipolar they complete the path from the sensory field to the muscle; and this path leads to the muscles of the opposite side from the stimulus because the conductors from the sensory field pass across the motor path of the same side to establish synapses with the dendrites of the commissural cells in the floor plate. . . ." (76, pp. 12-13).

A similar, but usually much less completely worked-out neural picture could be presented for each organism the development of whose behavior has been considered above. For example, the anatomy of the nervous system of the fetal rat in relation to its behavior has been studied in

quite elaborate detail by Angulo y González (3-5, 7). Minkowski, who is primarily a neurologist, has given in great detail the neural mechanisms which he believes underlie the changes which he has observed in the clinically significant reflexes initiated by the stimulation of the sole of the foot (238; 241, pp. 548-556). While there is almost complete agreement that the nervous system is significant in the onset and development of mammalian behavior, there is not complete agreement as to the essential factors of this development. Possibly the most commonly held view in regard to the basis of functional activity in the nervous system is that which asserts that there is a differing threshold of stimulation at the synaptic junctures existing between neurons. Sherrington and his associates have recently reviewed the evidence for such a view (95, pp. 14-15), and previously both Herrick (142, pp. 103-111) and Lillie (213) have dealt with special phenomena basic to an understanding of the synapse. Holt has shown how, in his view at any rate, this theory is adequate, when correctly understood, to explain the complexities of embryonic development, particularly when it is supported by a correct understanding of the functional development summarized in the theory of neurobiotaxis (153, pp. 24-29). Lashley and other students, on the contrary, have recently raised a number of objections to the synapse, particularly as *the* explanatory factor in the change of behavior (204, 165). For a consideration of the significance of nerve-fiber density in the spinal gray matter and behavior see Windle (342).

Since the time of Flechsig, there has been a tendency on the part of many students of neurology to link myelinogeny, that is, the development of the myelin sheath of neurons, with the onset of differentiated behavior. Flechsig, in his later publications, even attempted to correlate the degree of myelinization with increase in the complexity of behavior, and indeed with psychic life. Recently, Tilney and Casamajor (317), Langworthy (201), and other students have attempted to show the correlation between myelinization in the central nervous system and the onset of behavior in the newborn and fetal cat, opossum, and other forms. For the most part these investigators point out that this theory must be taken as specific to the particular function and to the particular type considered. Tilney, however, makes the statement in very general terms: "I think there can be no doubt as to the coincidence in the time of myelinization and the establishment of function" (317, p. 66). [See also (318).]

There is, however, some evidence that there are exceptions to this view, but probably it is no longer safe to say of this "myelinogenetic law," as Thorndike did in 1913 on the basis of the experiments of Watson (329) and others, that it seems "gratuitous and improbable" (315, p. 229). Certainly it seems that the evidence does not show it as *the* cause of the onset of behavior. As Angulo y González has shown, "from the point of view of myelinogeny, our studies have proved that myelination is not necessary for function, since all the movements described by Dr. Swenson and myself in the rat fetus occur many days before myelination could be

observed" (6, p. 462). This author objects to the observations on behavior made by Tilney and Casamajor, believing that the movements which they observed were really established long before the time at which they were described and hence well before the myelinization which they report. Angulo y González, moreover, finds that a rat fetus, nineteen days after insemination, is capable of "discrete reflexes and of showing the inhibitory action of higher centers.

> "These discrete reflexes, which are specific to given stimulation, demonstrate a selectivity in the conducting mechanism. Since myelination does not take place until several days after birth, this observation proves that physiological insulation of the conduction path occurs without myelination, and therefore, that myelination is not a criterion of functional insulation" (6, p. 461).

Following the lead of Paton (262, 263) and other investigators, Lane (193, pp. 15-21) holds that the onset of behavior is specifically related to the anatomical development of the neurofibrillae. This investigator advances an elaborate series of arguments to show that the neurofibrillae are possibly to be thought of as the essential basis of functional activity in the nervous system.

> "If therefore an absolutely conclusive answer cannot now be given to the question of the function of the neurofibrillae, it is most probable, in the light of our present knowledge in this field, that the power of conducting nerve-impulses lies rather in the neurofibrillae than elsewhere. At any rate, the presence of neurofibrillae may be taken as an indicator, a criterion of the functional state of the neurons . . ." (193, p. 21).

After definitely accepting this view, Lane explains the fact that after the neurofibrillae have developed, before the arc can become functional, it is necessary that the receptor develop. In each of the senses he believes that function must wait for the development of the end-organ, and that this is the last link to be connected up in the chain between effective stimulation and response (193, pp. 14, 79). In all of the explanations which he offers for the development of this system he emphasizes intrinsic rather than extrinsic factors (193, p. 84). In this he is seconded by Avery, who concludes that fetal behavior is, without further explaining the matter, in part, at any rate, dependent upon "certain response mechanisms which are definitely congenital or innate" (13, p. 324).

More recently Windle, in studying the spinal-cord development of cat embryos 17.5 to 18.5 mm. long in which the first movement—"wormlike, total waves proceeding caudad from an indefinite point in the neck region"—had been observed, notes that:

> "Pyridine-silver preparations of these embryos demonstrate the neurofibrillar structure of the central nervous system. Primitive reflex arcs are distinguishable, afferent, association, commissural, and efferent neurons appearing in proper relationship to each other . . .

The earliest movements appear in regions where primitive reflex arcs were first distinguishable and not until some time after these have formed" (341, p. 249). [See also (343, 344).]

Herrick, in referring to neurofibrils, says, "They are commonly regarded as the essential conductors of the nervous impulse, but of this there is no direct evidence" (142, p. 108).

Recently there has been an increasing tendency to suggest that the neural functions and capacities of the adult organism are related primarily to the time relationships of activation in the neuron (Lapicque, 202). Or, even more generally, it has been suggested that the facts of the activity of the peripheral nerve fiber, as developed by Adrian and his predecessors and associates, may be basic to some aspects of the differentiation and specificity of behavior. Indeed, Forbes has recently written an article, "The Interpretation of Spinal Reflexes in Terms of the Present Knowledge of Nerve Conduction," in which the suggestion is very tentatively made that specificity of behavior and "the evolution of the dominant activities of man" (121, p. 414) may be thought of as being determined in a system the essential characteristics of which are to be found in a knowledge of the facts of the nervous impulse as it is seen in peripheral nerve fibers. Weiss has likewise interpreted this relationship but from a different physiological point of view (336).

Certainly the increasingly detailed knowledge in regard to the specific structure and function of the receptors, the peripheral nervous system, and the various levels of the central nervous system, particularly in regard to the relationships between these processes as brought out by Sherrington and his pupils, must be ultimately taken into consideration in an explanation of the onset and early development of behavior (95).

Pankratz has suggested that the onset of behavior is in time, at any rate, related to the beginning of functional action of the secretion of the suprarenal medulla, "causing an increase of the irritability of the muscular or neuromuscular system and thus facilitating the beginning of fetal movement" (255, p. 235). He believes he has experimentally demonstrated in newborn organisms, including man, that there is a temporal correlation between the onset of functional activity in this gland and the first responses of the growing organism (257).

On the other hand, there are those who emphasize the part played by various forms of internal and external stimulation in the onset of activity in the organism. The importance of the changing chemical constitution of the blood as a determiner of the onset of behavior has been considered as most important by many, as noted in several places above. In connection with this knowledge, it has become obvious to many investigators that other movements than those of respiration are brought about or facilitated by asphyxia in the fetus. Kussmaul considers this relationship between "blood stimulus" and the onset of general fetal movements. He reports a case in which extreme loss of blood on the part of a human mother brought about movements in a very early fetus (192, p. 31).

Preyer also considers the importance of the blood condition in connection with fetal movements on the basis of experiments in which he interfered with normal respiration (277, p. 417). As already indicated, Ahlfeld and most of the other students of premature breathing movements have considered the "blood stimulus" as significant. This sort of activation is also especially considered in the work of Zuntz (354), Walz (326), Brown (39), Graham (131), and Tracy (322), all of which has been previously reviewed.

Tracy well combines the view of the importance of stimulation and the importance of the development of the nervous system in the determination of the onset of behavior in larval organisms. Thus he says:

> "The behavior reactions displayed by embryos and larvae of different species at different stages of development are dependent upon the relative time at which efficient connections are established between the various elements of the early nervous system (primitive bilateral motor system, commissural elements, spinal-ganglion cells, Rohn-Beard cells, and receptors)" (322, p. 357).

But he also points out that "from the beginning, and more or less continuously during its whole existence, the animal is driven through its environment as a result of stimuli which arise periodically in connection with its metabolic processes" (322, p. 345). For a consideration of the effect of endogenous stimulation in the mammal see Angulo y González (9).

Besides such students as Tracy who emphasize both the nervous system and stimulation, there are some who emphasize the rôle of stimulation in the onset and development of behavior without much reference to the neural basis of such behavior. Kuo is an outspoken exponent of such a view. He says:

> "As has been previously stated, I am inclined to think that to explain the total behavior pattern in terms of neural anatomy (that is, in terms of certain special connections between neurons) seems unnecessary or far-fetched, since all the neurons in the nervous system are interconnected in some way, and since body parts without direct neural connections may also move together, as in the case of the synchronous movement of the tail with the beak and eyes" (191, p. 511).

The reader of the above paragraph is probably struck at first by the question: "If the assertion is true, how is the observed differentiation in behavior to be explained?" Kuo offers the explanation that local reflexes are determined in part by environmental influences. In the case of the chick he has ingeniously made many observations, some of which have been presented above, to show that in the fetal organism, growing in a rigidly shell-defined environment, certain mechanical influences interfere with the ease of general movement. For example, head movements come, as development goes on, to be interfered with mechanically by the yolk-sac, and thus he explains the fact that partial head movements, such as those

of the beak, come to occur in the head region (191, p. 505). Kuo also believes that the absolute strength of stimulus is important in determining whether a response will be local or general. While both of these factors may, subject to experimental confirmation, be found to be extremely important in the development of behavior, it seems to the present writer, at any rate, that Kuo is far from justified in dismissing the selectivity of the nervous system in quite such a cavalier manner as he has done. This same criticism seems to hold in regard to those supporting the extreme organismic hypothesis in regard to the nervous system (165, 166).

On the basis of elaborate experiments, Lashley and his predecessors have shown that there was much misunderstanding in regard to the absolute specificity of central-nervous-system elements which subtend behavior particularly in the higher centers (205, and bibliography cited there). Lashley's work and the work of many other students makes clear the fact that no neuron is probably ever functionally absolutely isolated and that the reflex arc is never as simple as the elementary textbooks of twenty-five years ago showed it to be. Indeed, this investigator's brilliant experimental work has revolutionized the older conceptions of the specificity of the arcs in the higher centers of the animals that he has studied. From these facts, however, there is much question as to whether or not Irwin is justified in suggesting that "the early form of activity, with its lack of mature specificity and the presence of so few effective coordinations or reaction patterns, probably points to an organismic rather than to a reflex chain theory of behavior" (166). The present writer has no wish to disagree with this statement, save only to point out that the "cell theory" and the "reflex theory" that are usually attacked are in most such criticisms truly "men of straw." All that has gone before in this paper seems to suggest that the explanation of behavior will hardly be advanced by saying that the "nervous system operates as a whole." Unquestionably, in the human fetus as in the human adult there are functions which can never be understood in isolation, but by looking at the *totality* alone the specific long, short, homolateral, and heterolateral skin reflexes, the face, hand and foot reflexes, the mucous-membrane and tendon reflexes, the proprioceptor and static reflexes, and the many other specific responses of the fetus will never be scientifically explained. Because an early concept of the reflex was inadequate seems to be no reason to assert that there is no truth in the general view that behavior involves relationships between stimulation and response, some of which are more variable and some more specific than others. As Skinner has recently effectively said in summary of a paper in which he criticizes current attacks upon the reflex hypothesis:

> "The essence of the description of behavior is held to be the determination of functional laws describing the relationship between the forces acting upon, and the movement of, a given system. The reflex is, by definition, the precise instrument for this description" (296, p. 455).

Certainly there have been ill-judged efforts to make behavior seem

simpler than it is. External stimulation is not, it seems, *alone* important in the development of behavior, nor probably is the change in the synapses, or some other factor, *alone* the one determinant of all responses in all organisms at all times. It seems at present, nevertheless, that so far as the fetus is concerned there can be little doubt that an adequate explanation of its behavior at every stage in its development must be given in terms of the dynamics of its total organization. Such dynamics, however, can be expressed only in terms of as adequate a knowledge of the relevance and particular structures and functions of the organism as possible. Any response can be understood only if it is recognized that it may not be the result alone of the most obvious stimulus that is apparently calling it out, but rather that it may be a resultant of the total interoceptive, proprioceptive, and exteroceptive stimulation of the moment.

In a final understanding of the sensory control of behavior in fetal life as complete a knowledge of all such relevant factors as possible is important. Seldom apparently during late fetal life can an exteroceptor be stimulated so as to bring about a response that may not be conditioned also by internal stimuli which are at the time tending to drive the organism "at random." This is particularly true of fetuses such as those studied by Minkowski and Bolaffio and Artom, which during observation are always undergoing more and more complete asphyxiation. Indeed, it may be that at certain periods of development and in certain physiological states the exteroceptors are best thought of as interrupting and directing behavior that is internally aroused. In any case, in a situation of this sort, gradually more and more adaptive behavior develops.

The question arises as to whether or not this development can be summarized in a single formula. Coghill has presented a formula, possibly an adaptation of Spencer's famous definition which held evolution to be a passage from "a relatively indefinite incoherent homogeneity to a relatively definite coherent heterogeneity" to the growth of behavior in ontogeny. He believes his formula has wide if not universal application in the development of behavior in all vertebrates. He states it as follows:

> "The behavior pattern from the beginning expands throughout the growing normal animal as a perfectly integrated unit, whereas partial patterns arise within the total patterns and, by a process of individuation, acquire secondarily varying degrees of independence . . . complexity of behavior is not derived by progressive integration of more and more originally discrete units" (74, p. 989).

On the basis of what has gone before in this paper it seems that this process of *individuation* is certainly one important means of describing the process of development. On the other side, but not necessarily temporally concomitantly, *integration* has long been considered as a mechanism of behavior development. As Pavlov has recently put it in another context, one must consider the "initial decomposition of the whole into its parts or units, and then the gradual reconstruction of the whole from these units or elements" (266, p. 102).

In terms of a very broad generalization, the present writer believes that an excellent case can be made out for the view that *individuation* is the pattern of all development, including all learning, but certainly in the experimental situation the concept of the *integration* or the combination of responses also provides, at times, a convenient working hypothesis. James said many years ago that "psychology must be writ *both* in synthetic and analytic terms" (170, Vol. I, p. 487). To the present writer this seems to give a satisfactory clue to the expedient way of considering the changes in behavior that occur as fetal and neonatal behavior progresses. As we have seen above, certain responses are early individuated while others are still quite non-specific. New relationships between specific responses as in the development of the plantar reflex begin to develop before specification has gone far in certain other bodily acts. Each process must be considered at each level if a false generalization is to be avoided.

Genzmer, after reviewing the debated question as to whether or not the newborn child has intelligence, suggests that the observed movements of the early infant are not the result of intelligence but they are rather the material out of which the later intelligence is to be built (123, p. 28). If the process of development is one of sheer individuation out of a totality, it would seem that statistical studies of early infancy might well show a high degree of what Spearman calls a "general factor." If the techniques used in the studies of Furfey, Bonham, and Sargent (122*a*) are satisfactory, however, it seems that the opposite is the case. In a study of seventeen responses such as the plantar and grasping reflexes in newborn children corrected intercorrelations proved to be zero. These investigators conclude, "These results suggest that there is no mental integration in the newborn child. Integration takes place during the first postnatal month . . ." While there are a number of technical objections that may be raised to this study, it certainly seems that, with the use of the same techniques, there is no reason to suppose that the responses of the fetus would show a more general factor than would those of the newborn child. Minkowski (239) has considered the part played by the conditioning of reflexes in later development, and certainly the question of the relationship between *individuation* and *integration* will be made more clear when it can be said at what ontogenetic level of development true conditioning of responses is possible. Ray (281) has attempted to condition fetal responses, but as yet has not succeeded. Marquis (227), however, has brought about conditioning of the food-taking reaction to the sound of a buzzer in the newborn child. She holds that this may be conditioning at the subcortical level, but in any case it involves what is commonly considered as combination rather than individuation of responses. It is possibly true that all conditioning can be described as individuation, but to do so seems to require a generalization of the concept of individuation beyond the point at which it is pragmatically most useful.

In general conclusion, then, in regard to the sensory control of behavior

in the fetus and in regard to the related processes of individuation and integration, it seems that as yet, at any rate, it is better to record as unambiguously as possible the responses that can be made at any stage rather than to attempt to fit all development into one formula. It seems to the present writer, nevertheless, that the actually recorded facts of this development of behavior in infrahuman and human fetuses have been shown to throw light upon certain of the insistent problems of psychology. It will be impossible to consider each of these processes in detail in this chapter. It seems, however, that in the later chapters of this book when, in postnatal life, problems of the development of behavior patterns, heredity and environment, the nature of instinct, the development of perception, the continuity or saltatoriness of development, and the problems of learning are considered, it will be obvious that the facts presented in this chapter will have a bearing on certain aspects of the answers that are given such problems. As Tracy (322, p. 253) has suggested, indeed, a study of adult behavior without a consideration of its origin before birth is as incomplete as would be the at present unthinkable study of adult anatomy without reference to the embryology of the structures considered.

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PART III

DEVELOPMENT OF CHILD BEHAVIOR AFTER BIRTH

CHAPTER 3

THE NEONATE

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INFRAHUMAN INFANTS[1]

The degree of maturity at birth differs markedly among the various Orders of Mammals. In some, the young infants have, or almost have, the adult form of progression. In others, the young organism is virtually incapable of coordinated movement from place to place. Some animals have their eyes not only open but capable of fixation; others are born with eyes closed. As the subsequent review will show, there is no fixed stage of reactivity at which all animals are born. In some, development advances further in the uterine stage so that the animal is equipped at birth with responses which in others do not occur until after a period of postnatal development. Thus comparative maturity at birth should indicate that the appearance of any given type of response may be attributed to growth processes rather than to environmental influences, unless it be claimed that the differences arise from different prenatal environments.

Roughly speaking, the degree of maturity at birth and the duration of infancy are in inverse relationship to the life-cycle of the organism and the extent to which the organism's behavior can be modified through learning. The relative helplessness of the newborn human infant and the extraordinarily long period of infancy have been held to constitute a decided advantage, since they subject the organism to environmental stimuli at a time when it is most susceptible to their effects.

Regardless of whether neural development is to be considered primarily maturational or induced by stimulation, the destruction of portions of the cerebrum of subhuman infants has least effect upon those infants which are least developed at birth and most upon the organisms showing highest development at this period.

One of the least developed animals at birth is the opossum (*Didelphis virginiana*). According to Hartman (75), when the eleven-day embryo leaves the vaginal orifice and climbs the mother's hairy abdomen to enter the pouch, it is about one centimeter in length, and, once in the pouch, it becomes attached to a nipple to stay for several weeks. After this period of weeks it may begin to make occasional excursions from the pouch. Langworthy (94, 96) observed that the hind legs of the eleven-day opos-

[1]The writer is deeply indebted to the Editor for the suggestion that this section be included in the chapter, and to Dr. T. C. Schneirla who offered valuable advice regarding the material and tendered his services in the reading of the manuscript.

sum scarcely participated in progression. At this stage grasping and alternate movements of the forelegs, as well as the sucking response, were observed to be well developed. The entire weight could be supported by one foreleg; while the sucking responses could be elicited by touching the face, whereupon the animal turned toward the side stimulated, and, if quite active, wide side-to-side movements of the head followed. (See *Sucking Response.*) As he found, at this early stage the tail will curl around an object but has no prehensile strength. Pinching a foot is followed by withdrawal of the member so stimulated. The most common reaction to stimuli is a general contraction of the body musculature, the greatest coordination and differentiation occurring in the anterior portion of the body. Spontaneous movements of this type are "continuous and futile," electrical stimulation of the plantar surface of the forefoot evoking a grasping reflex. These animals move towards "warm" and away from "cold" stimuli. The suggested mechanism of the pouchward progression is as follows: Progressive beats of the legs may arise through rapid peristalsis of intestines and "hunger pains" (see *Alimentation and the Neonate Organism*), or impulses may be generated when the fetal lungs fill with air. Direction of progression may arise through thermal or tactile stimuli. All these activities occur before myelinization has taken place in the nervous system.

Temperature regulation in mice is not very well developed at birth, and Stier and Pincus (168) report a dependence of frequency of respiratory movements upon the temperature, within certain ranges. Stier (167) finds that elimination of external excitation does not eliminate "spontaneous movements," and states that these result probably from activity in the gastro-intestinal tract (see *Alimentation and the Neonate Organism*).

Tilney and Casamajor (177), chief supporters of Flechsig's myelinogenetic law, assert that in kittens incidence of response is contingent upon the myelinization of definite tracts. Thus responses appearing shortly after birth have myelinated neural mechanisms, while those which develop later do not occur until *their* necessary neural mechanisms are myelinated.

Within a few minutes after birth, young kittens show a postural righting reaction, in that they turn belly side down from previous side or back positions. Next, there is progression, with side-to-side movements of the head, towards the mother. The progressive movements may be ascribed to heightened activity in the digestive tract, direction being determined by thermal and auditory stimuli. Contact with the nipple arises from tactile stimuli which exert a directive influence as the head moves from side to side. As long as the nipple remains in the erectile state, substances such as petrolatum or quinine solution cause no rejection or stoppage of the sucking reflex. The flow of milk into the mouth starts reflex swallowing activities which continue until the stomach becomes filled and peristaltic movement ceases. Then swallowing and sucking stop, although the nipple may still be lightly held in the mouth. The type of general movement earlier observed in the crawling approach shows a steady decrease in

amount as the stomach is filled (see *Alimentation and the Neonate Organism*). After the stomach has become replete the kitten is quiescent, now and then making a quick twitch of an extremity or the head or "a short convulsive twist of the entire body." These are similar in time and rhythm to reflexes evoked *in utero* by palpation.

All of the movements of the kitten during the first six days are similar to a pronounced ataxia, but by the seventh day the cerebellum becomes connected with proprioceptors and effectors, and steadiness and precision of movement are acquired. This initial lack of synergic action compares with the characteristic jerky movements of the newborn child (see *Reactions to Auditory Stimuli*).

On the seventh day a pin-prick releases localized responses of eye-opening and head-turning as contrasted with previous diffuse responses. Eye-opening, with pupillary reflex but with no winking reflex or apparent utility of vision, occurs in response to sudden sharp auditory stimuli and to a bright flash of light (contrast with human neonate). On the fourteenth day visual fixation and pursuit of a moving light or object (oculocephalogyric reaction) are to be seen, the movement occurring in the horizontal plane. A day or two later movement in the vertical plane also takes place. The optimum far point is about 4 inches. If the object is too small or not visually intense enough, or if it is moved too quickly, no response is made (see *Reactions to Visual Stimuli*).

Electrical stimulation of the cerebral cortex of kittens from birth to two weeks evokes only reactions of the contralateral foreleg. In older kittens, movements of facial masticatory muscles and of the hind leg are observable. This, Weed and Langworthy (183) note, corresponds to segmental differences in embryological development. But since myelinization of the pyramidal tracts does not occur until the ninth or tenth day, according to Langworthy (95), it is impossible to correlate excitation of foreleg through cortical stimulation with myelinization.

From the study of the behavior of fetal kittens Langworthy (97) concludes that progression in kittens may well be the result of the linking-up and coordination of various avoiding reflexes, in the same manner that locomotion in Amblystoma arises out of an avoiding reflex. Not all avoiding reactions are thus incorporated.

In addition to the responses mentioned, sneezing may occur. Also, stimulation of the side of the head causes it to be turned toward the stimulated side with initiation of sucking movements. There are analogies to the human infant in that "in the new-born kitten many stimuli give rise to sucking reflexes. In the older animals it will be seen that greater discrimination is soon developed." Of similar significance is the fact that "hunger and cold seem particularly efficient stimuli to elicit crying." Movements are not well coordinated and are jerky in character. A general sensitivity to stimulation of the body surface is shown. Dorsal stimulation causes a "caving-in of the back"; stimulation of the ventral

side, "a bowing of the back." These are comparable to the abdominal and *"Rückgrat"* reflexes of the newborn child.

In dogs the strength of the electrical stimulus necessary to elicit movement through excitation of cortical areas decreases with age, and the number of excitable points increases, according to Michailow (107). When newborn animals receive cortical stimulation at different points, the movements are generalized, all of the extremities being involved, whereas in adults differentiated or localized responses of different segments of the extremities may occur.

Michailow (108) contrasts pupillary and other eye reflexes in newborn puppies with those of newborn guinea pigs. Puppies have their eyes closed and do not develop these reflexes until the eyes have opened, while the guinea pig develops mechanisms for these reactions in the intra-uterine period.

Bahrs (9) studied a pinna reflex in puppies and also found that the young animals showed ocular "after-effects" while they were being rotated.

The guinea pig, as Avery (6) has demonstrated, comes into the world well equipped. Its movements show good coordination. It can change postural positions readily and "crawl, stand or walk." The eyes are open, lid and pupillary reflexes are present, and vision results in the avoidance of objects (later fetuses thus avoid obstacles). Auditory notes of high pitch release an ear twitch or slight jump, the response being elicitable also in the fetus (compare *Responses to Auditory Stimuli*). Loud noises "startle" it.

Lashley and Watson (99) in their biographical study of a young *Macacus rhesus* monkey report no pronounced sensitivity to auditory stimuli during the first week. Movements of other animals and of the experimenters are followed with the eyes. Even in the first week reaching occurs towards visually perceived objects, but most of the movements are of the "larger limb muscles," the fingers not being moved separately. During the second week reaching and grasping become more precise, and orientation with reference to sound takes place. The third week marks the establishment of greater control over the larger muscles, and the beginning of walking. Although the monkey infant clings to the mother from the first and reaches for perceived objects very early, it does not oppose thumb and fingers with success in picking up small objects even at the fifth week. Tests of olfactory sensitivity at this time produce withdrawal only to chloroform, with indifference to acetic acid and oil of cloves.

While human infants may support their own weight by both hands for a little over 2½ minutes, Richter (144) found one monkey which supported its weight for 33 minutes by one hand. The reflex attains maximum strength in from two to five weeks and then disappears about the seventh week. It may reappear pathologically, as it does in humans.

The Jacobsens and Yoshioka's (82) careful study of the baby chimpanzee, Alpha, furnishes parallels to the human infant in many respects.

FIGURE 1

GRASPING REFLEX OF A NEWBORN MONKEY

(From C. P. Richter's "The grasping reflex in the new-born monkey." *Arch. Neur. & Psychiat.*, 1931, **26**, 784-790. By permission of Dr. T. Weisenburg, Editor.)

Temperature regulation is deficient at first. The pupillary reflexes, although present at birth, are not precise but improve during the first week. Coordinated movements in following a bright light were observed. Auditory stimulation produced blinking, trembling of the pinnas, and, if intense, "vigorous generalized movements of the body." Differential feeding responses to water appeared during the first week and were more pronounced thereafter. Cutaneous areal stimulation below 20° C. and above 70° C. evoked pronounced reactions. A touch on any part of the body released a general response "like a strychnin convulsion." As development goes on, stimulation tends to release localized responses. The grasping reflex is

present from birth with a slight opposition of thumb and fingers. Weight can be supported with one hand for over a minute. No directed reaching and grasping was observed during the first month. The Babinski reflex was absent.

Beginnings of locomotion were noted in the first week in that, when placed on the stomach, the animal made alternate stepping movements and raised head and neck.

During the first two months poorly differentiated responses of fear and anger were observed. The "fear" response was characterized by "sustained clenching of the feet and hands, drawing up of the arms and legs, and a tendency to cling to objects; by wrinkling of the face and retraction of the lips; and by a high-pitched crescendo scream . . . . at times it (the response) involved the entire musculature in a tonic spasm."

The major part of the time the infant was asleep, activity being most pronounced at feeding-time. In general, diffused and generalized responses were observed in the beginning, these giving way to more localized and specific responses.

Fetal Behavior

For the evolution of behavior and an inventory of the same during the fetal period, Carmichael's material in this volume should be consulted as well as Minkowski's (110, 111) extensive experiments upon human fetuses delivered by Caesarean section. Special aspects of fetal behavior *in utero* have been treated by Ahlfeld (1), Reifferscheid (141), and Peiper (122). Krabbe's (88) work and Bersot's (20) study also merit attention.

Birth

Significance. Birth, popularly regarded as a saltatory phenomenon, receives an emphasis which tends to obscure the real significance of the incident in developmental history. Birth represents a transfer (attended with difficulty to mother and child) of the developing organism from one type of environment to another. For the child psychologist this removal to a more complex and extensive environment has greater significance than the establishment of autonomy of vegetative functions.

Vegetative Changes. Prior to birth, the fetal respiratory, digestive, and excretory systems are practically non-functional, the corresponding vegetative processes being mediated through the placental exchange between the circulatory systems of the mother and the developing child. When the placental connections become disturbed at birth, basic respiratory and circulatory changes occur which alter the functions from fetal to natal types.

There are two major theories as to the initiation of pulmonary respiration according to Feldman (58) and Fernandez (61). One holds that cutaneous stimulation (contact and thermal)[2] innervates the musculature

[2]The gasp following application of a cold temperature cylinder to the middle of the forehead seems to substantiate this effect of thermal stimulation (139).

of the thorax and that atmospheric pressure cooperates to fill the lungs, expiration following relaxation of the muscles and succeeding inspirations being set off by neural discharges from the respiratory center. The other theory advanced makes the degree of venosity of the blood the factor operating directly upon the respiratorv center to start respiration. Probably both factors are operative.

Fetal circulation changes to natal type with the first inspiration. A complicated series of valves close in such fashion that blood now flows to the lungs rather than to the placenta for aeration. Of significance also is the fact that natal circulation provides a greater part of the organism with pure blood than did the fetal type.

Environmental Changes. The extra-uterine environment extends the range of intra-uterine modalities of stimuli and introduces new modalities. The developmental rôle of the postnatal environment has been the subject of much controversy. Certain animal experimentation has shown no dependence of myelinization of optic nerve fibers upon visual stimulation. On the other hand, Bersot (20) claims that premature infants, when they arrive at the age of full-term infants, present certain behavior coordinations which are superior to those of full-term infants. Aside from the developmental aspect, the extra-uterine environment certainly provides greater opportunities for the conditioning of responses.

Birth Trauma. The extent of serious birth injuries to the nervous system, other than those causing almost immediate death, is not well established. Ford (62) believes that they are not very numerous, while others take a more serious view of the matter. Exhaustive investigations of birth injuries to the nervous system have been made by Schwartz (155) and Dollinger (52).

Birth injuries to special sense-organs are illustrated by Kutvirt's (92) and Vosz's (179) correlation of lack of auditory sensitivity with prolonged and difficult labor and Sicherer's (162) finding of temporary retinal hemorrhages in the just-born infant.

Definition of "Neonate"

The term *neonate* is a Graeco-Latin derivative. In common with the respective Italian, French, German, and English equivalents (*neonato, nouveau-né, Neugeborener,* and *newborn*), it lacks descriptive precision. From this viewpoint, the Spanish *recien-nacido,* derived from the Latin *recens natus,* meaning the *recently born,* is to be preferred. Further vagueness in terminology is contributed by the use of *Säugling, nourrisson,* and *suckling* (terms arising out of sucking phenomena during the first year of life) to designate the period from birth to the termination of this mode of feeding. The adjective *younger* is not sufficiently definitive.

Duration of Period. For some authors the term *newborn* comprises the period from birth to the seventh or tenth day, or until the original birth weight is regained; others extend it to the twentieth day so as to include complete obliteration of the Ductus Botalli, the umbilical vein, and the

disappearance of characteristic phenomena such as asphyxia, umbilical infections, tetanus, icterus, obstetrical paralyses, etc.; Gundobin (70) considers it as ending when complete regularity of assimilation indicates the general integrated functioning of all organs; Vinay (178) would include the first three months in order to cover distinct psychological development.

In view of such diversity of opinion, it seems best, following Feldman (58) and Gesell (66), arbitrarily to define the period as extending from birth to the age of one month. This limitation confines attention to the nature of a human being at birth and to the period of maximum disturbance arising from the change to an extra-uterine mode of existence, with minimum maturational effects or addition of acquired or learned behavior to be discerned.

History of the Study of Neonates

Biographic-longitudinal. Feldman's (60) encyclopedic work reveals the earliest knowledge of the nature of the newborn infant as expressed in folklore and in the hygienic rules prescribed for mother and child in the religious writings of different peoples. Child study, as we know it, is scarcely more than a century old. The earliest studies were nothing more than scattered notes of curious behavior observed in infants. Later the diary or biographical method was systematized to give a more complete inventory or day-by-day and week-by-week account of development, the value of the work depending largely upon the training of the observer. Its virtues consist of the application of the genetic method over the first one, two, or three years of life. Its defects are bias (because of consanguinal ties) and lack of numbers, precluding normative study.

This method of study has been popular because of the accessibility of subjects and the lack of training required. Starting with the notes of Pestalozzi, the careful observations of Tiedemann (176), followed by those of Darwin (48), Champneys (36), and Binet (21), we come to the monumental work of Preyer (140) which still serves as source material for many child psychologists, as, for example, Koffka (87). Preyer's work still represents the greatest contribution made by this method of approach, even though works by Hall (72), Shinn (160), Lowden (102), Major (104), and at least fifty others followed.

The need for collection of data on more cases (a plural biography as it were) with more systematic observation led to the development of the questionnaire method at Clark University, which, under Hall, became a world leader in child psychology. Applications of the questionnaire method to the early phases of development were made by Simon (163).

Cross-sectional Experimentation. Even before Preyer's biographical masterpiece, cross-sectional experimentation upon numbers of newborn infants had been started by such pioneers as Kussmaul (91), Genzmer (65), and Kroner (90). Later studies were made by Peterson and Rainey (133) and Blanton (22). Besides general investigations of this type, special studies of particular responses were made, as, for example,

Engstler's (57) observations of the plantar response in one thousand children. Many other special studies involving numbers of individuals, but with little control of stimulating conditions or objective measurement of reactions, have been made. One of the best of this type is the work of the Shermans (159) which shows the utility of combining statistical treatment with careful qualitative observations. However, Bersot (20), in his researches upon the plantar response, had preceded them in recognizing the utility of this procedure, claiming as he did that physiologists had too long neglected the variability of responses.

Controlled Stimuli and Objective Records. It was soon recognized that reliable data are dependent not only upon numbers but upon better control of stimulating conditions, and upon substitution of quantitative registration and measurement for qualitative observation and description. Bechterew (17) made practical suggestions concerning methods of objectively studying the various activities of young infants. Canestrini (30) followed with graphic quantitative measurement of circulatory and respiratory changes to stimuli of different modalities. Benedict and Talbot (18, 19) developed a crib-recorder which would give them quantitative registration of "spontaneous" movements, and made the first 24-hour studies of the general activity of the newborn. Peiper (119) used the Canestrini technique, developed better stimulus control for temperature and pain stimuli, and devised a way (124) to record automatically certain reflex activity upon the tape of a Morse-apparatus. Eckstein developed a new

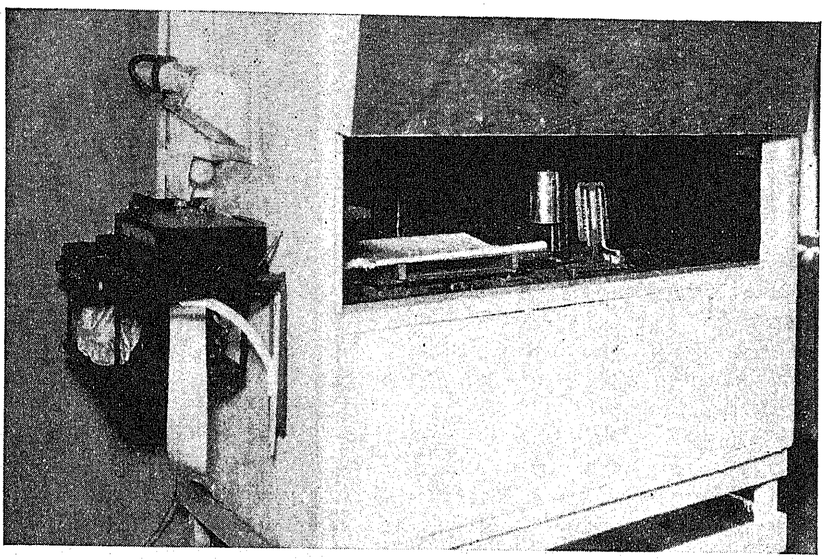


FIGURE 2

MOVABLE EXPERIMENTAL CONTROL CABINET WITH STABILIMETER AND POLYGRAPH UNITS

technique for measuring the character of respiration by means of a facial mask and pneumatic system, improved the instrumentalized study of the sucking response (54), and devised apparatus (55) for measuring the activity of the neonate. Carlson and Ginsburg (31), Taylor (172), and Schmidt (154) measured the stomach contractions of the newborn. Sherman (157) approached the study of emotions through motion-picture photography. At the Yale laboratory a photographic dome making possible the taking of motion pictures from different angles was devised under the direction of Gesell—later, sound pictures were made. Both at Yale and at Minnesota there was a return to the longitudinal type of study. At Ohio State University, Weiss and his associates (184, 139, 64, 80) constructed a special experimental control chamber with a stabilimeter-polygraph system (142) for graphically recording the reactions of newborn infants. Extensive studies of reactions to different modalities of stimuli were made by Pratt, Nelson, and Sun (139), as well as 24-hour studies of general activity by Irwin (78). An experiment in conditioning newborn infants to auditory stimuli was undertaken by Marquis (105). Jensen (83), with improved devices, was able to control stimuli and obtained graphic, quantitative records of the effects of various stimuli upon the sucking response.

The Physiology of the Neonate

Circulation. The fetal course of circulation changes to the adult type with the beginning of pulmonary respiration. The cardiac rhythm decreases, while the blood pressure increases with growing age. In the newborn child pulsation at the fontanelle can serve, as Canestrini (30) and Peiper (119) have demonstrated, to indicate the sensitivity of various receptors to stimulation. It is significant that a correlational activity such as circulation should be affected by stimulation of most all receptors. The effects are general rather than specific or differential.

Respiration. Pulmonary respiration of the neonate differs from that of the adult in rhythm (breaths per minute equal 35 during first month, 16 in adult), regularity, and type. It also serves as a general index of the reactivity of receptors, the effects, as in circulation, being general rather than specific.

Alimentation. Most mammalian infants undergo an initial loss of weight. The human infant loses until about the middle of the first week and then registers successive gains which recover the losses by the seventh to the tenth day. Conflicting theories regarding this loss of birth weight hold that it is due (*a*) to scanty milk production; (*b*) to imperfect assimilation, since supplementary feeding does not prevent all loss; (*c*) in part to unavoidable mechanical losses, loss of water for example, and in part, as Talbot (169) and others maintain, to avoidable physiological losses. He has shown that loss in weight coincides with the presence of colostrum in the mother's milk. This substance provides for only a fraction of the energy requirements of the newborn child, the remainder being supplied

by a breaking-down of the fat reserves which of course entails a loss in weight.

Nothmann (118) obtained gastric juice after infants that had not yet nursed were allowed to suck upon an empty bottle, and concluded that there were innate direct reflex connections between the sucking act and secretion. Schmidt (154) is unable to support this view.

"Hunger" contractions differing from those of the adult only in the shortness of periods of quiescence between periods of contraction were observed by Carlson and Ginsburg (31) in infants that had not yet nursed. They hold that a relationship exists between the vigor of these contractions and the awakening and crying of the infant. Taylor (172), in more exhaustive work, confirms Carlson and Ginsburg although he does not consider hunger the immediate cause of crying. He found no evidence of inhibition of "hunger" contractions when substances were introduced into the mouth. Inhibition, temporary at least, did occur upon introduction of water or milk into the stomach. In an eight-months-old infant transitory inhibition followed the introduction of sugar water into the mouth. The onset of activity is as follows: "The first contraction period is apt to be short. After a wait of perhaps twenty minutes, a longer and more intense hunger period arrives; then another and another. The infant's sleep becomes lighter. He is more easily awakened by external stimuli or by gastric discomfort. He is put to the breast, nurses vigorously, becomes fatigued or experiences satiety from distention, and again goes to sleep."

Reflex excitability mounts with increase of stomach contractions. Often these contractions are accompanied by automatic sucking movements.

The average time required for the development of "hunger" in healthy newborn infants under two weeks of age is 2 hours and 50 minutes; in those from two weeks to four months, about 3 hours and 40 minutes. Feldman (58) holds that this supports the European spacing of nursing periods by three hours rather than the longer American interval. It should be noted that hunger contractions start before the stomach is empty.

Excretion. Frequency of micturition has been noted but there are apparently no systematic studies of the relation of this and of defecation to times of feeding, bathing, or to the application of external stimuli such as thermal and auditory.

Although partially obscured by other factors, it is apparent that activity increases just before micturition and again, probably because of thermal stimuli, a short time afterwards, as the investigations of Pratt, Nelson, and Sun (139) and Pratt (137) have shown.

Secretion: Duct Glands. Most of the duct glands are functional at birth, although secretion may be limited in amount and restricted to specific stimuli. As has been stated, digestive secretions are ready shortly after birth. Jacobi and Demuth (81) find the salivary secretion difficult to obtain since it occurs only during the feeding act. Sweat and tear glands secrete, but tears may not be associated with crying.

Mammary secretion in most newborn infants, regardless of sex, is reported by Apert (4) and Arteaga (5). The former's chemical analysis shows marked resemblance to mother's milk. Both workers consider the secretion a physiological consequence of the action of placental hormones. In conjunction with the phenomena of enlargement of the uterus in females, congestion and hypertrophy of the genitals with erection of the penis in males, congestion of the thyroid, presence of lanugo (fine down over the surface of the body), and skin conditions involving the sebaceous glands, a picture analogous to certain aspects of puberty is presented. Feldman (60), however, regards mammary secretion and genital congestion as pathological.

Secretion: Ductless Glands. With little clear-cut evidence regarding its exact functions, the thymus has been termed the gland of infancy—it being said to have an inhibitory influence upon growth and particularly upon sexual development.

Metabolism. Birth represents a stepping-up in activity of the individual. In terms of unit weight the metabolism of the newborn child is 2.5 times greater than that of the mother. In terms of unit surface, however, Carpenter and Murlin (34) tell us, it is not above that of the nursing mother but is above "that of a woman in complete sexual rest." A crying baby may show metabolism three times as great as one that is sleeping quietly. This tremendous range is also shown by Pratt, Nelson, and Sun's (139) and Pratt's (137) measurements of the general activity of crying or restless infants.

Talbot (169) finds that the *basal* energy requirement increases with age. From one and a half to six days 44 calories per kilogram of body weight are required—at four to five months, 55 calories.

Twenty-four–hour metabolism studies of two infants led Talbot (170) to conclude that the *total* energy requirement necessitates approximately 100 calories per kilogram of body weight in the food in order to maintain normal activity and growth.

At birth the imperfect functioning of temperature-regulating mechanisms makes the human infant slightly poikilothermic, a condition lasting a few hours at most, according to Herzfeld (76). In the premature infant low body temperature presents a grave problem, in the light of Levy's (101) mortality figures. Healthy newborn infants, Talbot (169) asserts, tend to maintain their own body temperature through increased muscular activity, crying, etc., in response to a lowering of environmental temperature.

For anthropometric measurements and norms of physical growth Mies (109), Tanner (171), Taylor (173), and Baldwin (10) will serve as introduction.

Neuromuscular Physiology. The early studies of Soltmann (164, 165), A. Westphal (185), and C. Westphal (186) seemed to prove that the nerve and muscle tissues of newborn mammals are much less irritable than those of adult animals. Subsequent researches upon human neonates

by Peiper (125, 130), Rothe (147), and Banu and Bourguignon (11, 12) tend to confirm this view, but both Peiper and Eckstein (55) warn that this is not to be interpreted as conditioning slow movements. Rothe (147) finds, moreover, that irritability is greater to mechanical than to electrical stimulation.

Rothe (147) reports that the chronaxie of M. flex. carp. uln. is greater in premature infants than in the newborn and that it continues to decrease with age. Banu and Bourguignon (11, 12) find sharp differentiation in the chronaxies of different muscle groups in adults whereas in newborn infants there is little differentiation. Their chronaxies are from 2-10 times those of the adult. Furthermore, the neonate chronaxies are greater in proximal rather than distal segments—exactly the reverse of the adult. Banu and Bourguignon (12) associate this with greater movement of distal segments of extremities, an observation seemingly counter to Irwin's (78) and Shirley's (161) statements as to the order of development of movement.

The muscle chronaxies attain adult values in from seven to twenty months, while the nerve chronaxies more nearly approximate adult values from the beginning, and arrive at that point in about two months.

Peiper (124, 125) studied the reaction-times to pain and auditory stimuli (see those sections).

Since Flechsig's time, the developmental appearance of behavior has been ascribed to the progressive myelinization of neural tracts. Such interpretations have been challenged by Bersot (20) and Minkowski (110), who hold that there is good evidence of function even before myelinization. At this time the problem cannot be said to have been entirely solved.

Sensitivity

1. *Reactions to Visual Stimuli*

Sensitivity. A variety of reactions such as the pupillary, palpebral, and oculocephalogyric reflexes, as well as respiratory and circulatory changes, offer convincing evidence of the sensitivity of visual receptors.

Whether mechanisms exist for differential visual responses to the three characteristics of the visual stimulus has not been experimentally determined for the neonate. A relation does obtain between the incidence and extent of certain reflexes and the intensity of the stimulus. The experiments of Pratt, Nelson, and Sun (139) are unfortunately non-crucial in determining whether equation of chromatic and non-chromatic stimuli in terms of equal candle-power means equal stimulating value for neonates. Even if the same groups had been used for the experiments with chromatic and with non-chromatic stimuli the general illumination which they employed would tend to produce dark-adaptation and therefore change in intensity values of the chromatic stimuli.

Peiper (128), discovering an eye-neck reflex (*Augenreflex auf den Hals*) which was dependent upon the intensity of the light stimulus, con-

ceived a brilliant technique for ascertaining whether the cones are at all functional. In adults, dark-adaptation means a shift in brightness from the long-wave to the short-wave end of the spectrum (the Purkinje phenomenon). The totally color-blind have no such shift. Hence, if there is no difference in stimulating action with dark-adaptation as contrasted with light-adaptation in the neonate, one might conclude that only rods were functioning. But if the Purkinje shift does occur the cones are in that respect functional. Peiper's experiments demonstrated this shift not only in full-term but in premature infants as well.

Stimuli. The intensity characteristic of the stimulus appears to determine the occurrence or extent of most of the reactions observed. Moving stimuli determine a certain amount of fixation associated with the pursuit movements by head and eye.

Kussmaul (91), Genzmer (65), and Kroner (90) observed a lively pupillary reflex even in premature babies. The Shermans (159) found initial sluggishness at three hours with rapid improvement up to thirty hours of age. A consensual pupillary reflex is reported by Preyer (140) and Feldman (58). The pupil of the neonate is much smaller than that of the adult in sleep, and there is no sudden dilatation to a maximum upon awakening, according to Gudden (69). Whether dilatation of the pupil occurs in response to other stimulus modalities is debatable. Some experimenters place the beginning of such effects in the second month. Bartels (13) and Peiper (128) find dilatation during the first month in response to intense cutaneous stimuli, needle-jabs, and auditory stimuli, although the latter worker discovered little regularity of occurrence. In adults the "*Irissaum*" (margin of the iris) is in continual movement, being increased by external stimuli, emotional disturbances, etc. Peiper (126) could not discover this phenomenon during the first month.

Blinking. The palpebral reflex (closing of eyes or further tightening if already closed) was observed by Kroner (90). Preyer (140) differentiates this innate blinking in response to visual as well as to auditory and contact stimuli from the winking that occurs at about the end of the second month when an object approaches the eye. Pratt, Nelson, and Sun (139) noted that blinking was the most invariable response that was given to discontinuous stimulation.

Fixation. Genzmer (65) and Preyer (140) observed fixation upon a bright light shortly after birth, and the Shermans (159) report an improvement in this response up to thirty-four hours. Strabismus is noted even after possibility of coordination has been demonstrated. Gutmann's (71) results are similar. Peiper (129), however, holds that there is no real fixation until the third month.

Accommodation. Little is known regarding the nature of the image projected upon the retina. Even if the ciliary muscle does contract, there is no evidence of coordination with movements of convergence, at present. Again, as Peiper (129) points out, the diameter of the eye makes it myopic and initial retinal hemorrhages further preclude clear-cut images. Against

this we may set Feldman's (58) view that the neonate possesses clear media for light transmission.

Oculocephalogyric reflex. Eye and head pursuit of a slowly moving light has been observed by Kussmaul (91), Kroner (90), Preyer (140), Blanton (22), and others. The best study of nystagmus and visual pursuit from the standpoint of technique is that of McGinnis (106) who used a rotating visual field and photographed the eye-movements of the child. He reports successful visual pursuit after the second week with head movements decreasing.

Ocular-neck reflex. Peiper (127, 128) discovered a reflex bending-back of the head in response to a sudden flash of light.

Umklammerung reflex. A bright, intense flash of light may release the "fear" reaction or *"Umklammerung"* reflex, according to Peiper (130). Pratt, Nelson, and Sun's (139) analysis of specific movements shows a higher incidence of this response during the first three days.

Circulatory and respiratory responses. Canestrini (30) compares the curves of increased circulation and respiration following intense visual stimuli to those obtained from a frightened adult.

Technique of investigation. It is very difficult to control and vary one characteristic of light while the others are kept constant; apparatus planned to these ends is not very readily adaptable to investigation of differential sensitivity of newborns. Canestrini (30) employed "Bengal colored flames," Peiper (128) used *"Tscherningschen Gläserkasten,"* and Pratt, Nelson, and Sun (139) used Wratten filters to provide chromatic stimuli. Canestrini (30) used graphic records of circulation and respiration as indices; Peiper (128) employed the "neck reflex" as an indicator; and Pratt, Nelson, and Sun (139) used qualitative description of movements, particularly palpebral reflexes, and graphic, quantitative registration of movements through a stabilimeter-polygraph system.

Summary. Newborn infants are sensitive to the intensity characteristic of light, their reactions consisting of pupillary, palpebral, cephalogyric, and convergence reflexes, the latter not very well developed. With intense stimuli and particularly during the first few days they show the "fear" or *"Umklammerung"* reflex and pronounced changes in respiration and circulation. With dark-adaptation they show the Purkinje shift of intensity.

2. *Reactions to Auditory Stimuli*

Sensitivity. Physicians and child psychologists have long debated the alleged deafness of the newborn infant. Kussmaul (91) found no evidence of auditory sensitivity, while Genzmer (65), another pioneer, held that not only do babies hear on the first or second day but that stimulation through heart beats, aortic pulse of mother, and uterine and umbilical sounds might stimulate the ear of the fetus. Kroner (90) observed great variability in auditory sensitivity, as did Moldenhauer, who, according to Preyer, found this type of sensitivity present even during the first twelve hours after birth. The reaction observed consisted of quivering

of the eyelids, wrinkling of forehead, head movements, screaming, and awakening from sleep. Repetition had no effect, or else had a quieting one. Poli (136), using the palpebral reflex as indicator, and Sachs (151), employing both that and the "fear" (*Schreck*) reaction, found clear-cut evidence of auditory sensitivity, as did Peterson and Rainey (133), Koellreutter (86), Canestrini (30), Blanton (22), Waltan (181), Peiper (122, 124, 130), and Pratt, Nelson, and Sun (139). That sensitivity is less during the first few days of life has been reiterated by Feldman (58), Löwenfeld (103), and Haller (73).

Auditory sensitivity thus shows great individual differences during the first few days of life. During the first three days some infants fail to respond to intensities of stimuli which later are adequate to evoke a reaction.

Causes of insensitivity. The following causes for the relative insensitivity of some newborn infants have been advanced:

1. that the middle ear is filled with mucous—Preyer (140), Böcke (23), Compayré (44), Feldman (58), and others;
2. that there is occlusion of the external auditory meatus—Preyer (140), Feldman (58), and others;
3. that position and other physical properties of the tympanic membrane make response to air vibrations difficult—Feldman (58) and others;
4. fixity of auditory ossicles—Compayré (44);
5. that cases of deafness in the newborn are correlated with the difficulty and duration of labor, and that even permanent injuries may thus arise—Kutvirt (92) and Vosz (179);
6. that the auditory nerve is imperfectly developed at birth—Shinn (160) and Stern (166). On the physiological side this is negatived by Peiper's study of the shock reaction *in utero* and of the circulatory and respiratory reactions of premature infants.

Stimuli. No differential responses have been observed to vibration rates other than the fact that easily observable responses are more likely to occur to high-pitched sounds. This observation made by Moldenhauer has been repeatedly confirmed by Sachs (151) who used tuning forks and Galton whistle, Waltan (181) (whistles and tuning fork), and Haller (73) (audiometer). That the magnitude and extent of the response is in some way dependent upon the intensity of the stimulus has been observed by many, although differences in infant reactions do not exactly correspond with adult intensity ratings, according to Pratt, Nelson, and Sun (139), but this relationship has not been systematically investigated. The stimulus characteristic, wave composition, has also received little attention although early writers thought the human voice to have specific stimulating effects. From Sachs to the present time investigators have found greater excitatory effects if the duration of the stimulus is short (as in noises) and either inhibitory or no effects with stimuli of longer duration (e.g., musical tones).

Types of response. The responses which the neonate makes to auditory stimuli are of three types: (*a*) sharply localized as in the cochlear-palpebral reflexes (closing of the eyes if they are open or a further tight-

ening of the lids if they are closed). If the stimuli are of low intensity or the infant has been stimulated repeatedly the response may occur alone, otherwise it accompanies (*b*) generalized responses involving the autonomic system and its effectors, thus producing changes in general vegetative functions (respiration and circulation), or movements of much of the musculature in a fairly typical pattern—extension with abduction of arms and legs, extension of toes with *"signe d'éventail"* (fanning) or, in extreme limitation, extension of the big toe alone, extension and spreading of fingers (arm and finger movements, if slow, being athetosic, i.e., jerky and spasmodic), a startled jerk of the body which may be followed by squirming movements and crying if the stimuli be intense; (*c*) of a generalized character, also, are the frequently observed inhibitory effects of auditory stimulation upon activity already present. One is tempted to liken it to the inhibition of responses in the postural adjustment of the adult who, on one stimulation, prepares, as it were, for a second appearance. Perhaps this is one of the responses later to be associated with the eye-head orientation with reference to stimulating object.

The cochlear-palpebral reflexes, which are quite pronounced even beyond the neonate period, according to Cemach (35), and the "fear" reactions were described in detail by Moldenhauer, Poli, and Sachs, the latter calling the gross muscular pattern a "fear" (*Schreck*) response. Following Moro (114), others showed that the *"Umklammerung"* reflex was also elicited by auditory stimuli. Watson (182) considered the pattern of response to be the primary emotion of fear; Löwenfeld and Stern termed it a "shock" reaction. It remained for Peiper to observe that there was really no essential difference between the "fear" reaction and Moro's *"Umklammerung"* reflex.

The autonomic component was studied by Canestrini (30) and Peiper (119). Inhibitory effects upon the Moro component were observed by Waltan (181), Peiper (122), and Pratt, Nelson, and Sun (139).

Relation to state of organism. The relation between ease of eliciting the response and the state of the organism was observed early. Poli (136) found the cochlear-palpebral reflex easiest to elicit when the child was asleep and hardest when nursing. Practically all investigators have observed the necessity for a comparatively quiescent state in order to detect respiratory and circulatory changes and to evoke the "fear" reaction. Some students have considered that release in the sleeping infant of the "fear" reaction was almost invariably followed by awakening, but the investigations of Peiper and Pratt, Nelson, and Sun do not lend support to this view.

To continuous or discontinuous stimuli. No systematic attempts to study the effects of continuous or repeated[3] auditory stimulation appear

[3]The writer presented a paper before Section I of the American Association for the Advancement of Science in Atlantic City, December, 1932, showing that activity during a period of discontinuous auditory stimulation was confined to the specific movements following stimulation and that the response rapidly declined in extent with successive repetitions of the stimulus.

to have been made, although Canestrini (30) noted a rapid decrease of circulatory and respiratory changes with repetition of the stimulus and Peiper (122) similarly found that the "fear" response of fetuses *in utero* usually occurred only to the first stimulus. Both argue that this decline is not a fatigue effect but the result of a certain inhibition. The palpebral reflex appears least affected by repetition of the stimulus but Johnson (84) noted rapid adaptation even here. Continuous stimulation has been of limited duration. Haller (73), with a stimulus of constant value and a duration of ten seconds, found evidence of a release of a pattern of response which upon occurrence began to disappear even before the stimulus ceased. The effects of continuous stimulation upon general activity are not known, and it is questionable whether such studies should be made unless duration of the stimulus is relatively short. In the two-months-old infant, Peiper (124) found the reaction-time to be about .25 seconds, being much longer in sleep. Premature infants showed a longer reaction-time even when awake. Canestrini's (30) curves indicate approximately the same result as Peiper's.

Learning. Aldrich (2) has suggested that the conditioned-reflex technique be used in studying auditory sensitivity of the newborn, and Marquis (105) believes that she has succeeded in establishing conditioned sucking responses to auditory stimuli.

Technique of investigation. Partial control of the stimulus characteristics has been effected through tuning-fork series, Galton whistle, and audiometer (Haller). Quantitative, graphic measurement of circulatory changes by tambour attachments at the fontanelle (Canestrini and Peiper), of respiratory changes through the pneumograph (Canestrini and Peiper), movements *in utero* through tambour attachments to abdomen of mother (Peiper), bodily movements of the newborn child through stabilimeter and polygraph recording apparatus (Pratt, Nelson, and Sun) and through electrical counters,[4] have been made.

Summary. The newborn infant shows varying degrees of sensitivity during the first few days due to mechanical features of the external auditory meatus, the tympanic membrane, and the cavity and the structures of the middle ear. Much of the insensitivity, temporary and permanent, that is found is correlated with the difficulty and duration of labor. The incidence of response is greatest to high-pitched notes and to sounds of short duration, with intensity an important factor. The responses take the form of palpebral reflexes, circulatory and respiratory changes, a pattern of responses of the general musculature variously termed "fear," "shock," and Moro's *Umklammerung* reflex, and in the case of already existing activity frequent inhibitory effects are to be observed.

The "fear" reactions are elicitable *in utero* and in premature infants but diminish in magnitude and extent upon repetition of the stimulus, the disappearance or reduction of the response probably being due to inhibitory

[4]See footnote on page 179.

mechanisms rather than to fatigue. Although the total bodily activity of a period is increased by repeated auditory stimulation, the excitatory effects seem to be limited to the specific responses rather than to a general heightening of activity or restlessness.

3. *Reactions to Olfactory Stimuli*

Sensitivity. Whether olfactory sensitivity may be ascribed to the neonate depends upon what are to be termed olfactory stimuli. Substances, such as ammonia and acetic acid, which cause pain or discomfort in the adult, elicit vigorous responses in the newborn infant, while other odorous substances have little or no effect. Starting with Kussmaul (91) and Kroner (90), and more recently held by Blanton (22), Watson (182), and Peiper (129), the view is expressed that the effective stimuli act upon tactile or pain end-organs. The observations of Preyer (140), Tanner (171), Drummond (53), and Canestrini (30) support this view, as do those of Pratt, Nelson, and Sun (139) who find that of activity following stimulation ammonia accounts for 59 per cent; acetic acid, 32 per cent; valerian, 5 per cent; oil of cloves, 3 per cent; and air, 1 per cent. Peterson and Rainey (133) and Jones (85), who do not take this analytical view, consider the sense of smell well developed in the newborn.

Stimuli. Indubitable responses occur only to stimulation by ammonia, acetic acid, and similar types of stimuli.

Responses. The reactions consist of the so-called "mimetic" movements: throwing-back of the head, wrinkling or grimacing of the face, squirming of trunk, and movements of the extremities, and frequently crying and sneezing. Sucking movements to valerian during the first two days of life are reported by Pratt, Nelson, and Sun (139).

Technique of investigation. Objective measurement of circulatory and respiratory responses was made by Canestrini (30). Pratt, Nelson, and Sun (139) secured polygraph records of stabilimeter oscillations caused by bodily movements, perfected a stimulating device controlling the amount and time of application of odorous substances, and used a non-odorous air control.

Summary. It seems probable that the avoiding or defense reactions, generalized squirming movements, "mimetic" expressions of "discomfort" or "unpleasantness," crying, and sneezing are due to tactile or pain rather than to olfactory stimulation.

4. *Reactions to Gustatory Stimuli*

Sensitivity. According to Kussmaul (91), Preyer (140), Peterson and Rainey (133), and Canestrini (30), taste is the most highly developed reaction at birth; Shinn (160) maintains that it is dormant; Blanton (22), that taste, smell, and touch are not yet differentiated. Differential facial reactions reported by the pioneer workers and by Pratt, Nelson, and Sun (139), and differential sucking responses described by Eckstein (54) and Jensen (83) would seem to preclude doubt as to the existence of discriminatory reactions to certain taste substances.

Stimuli. The most common substances used have been sugar, salt, quinine, and citric acid solutions. Pratt, Nelson, and Sun (139) and Jensen (83) used distilled water as a control, and with Canestrini (30) and Eckstein (54) made some progress in controlling the strength, temperature, and quantity of the taste solution used per stimulation.

Responses. Kussmaul regarded the reaction to salt, tartaric acid, and sulphate of quinine as "grimaces of dislike," while Preyer (140) maintained that differential facial expressions for each taste indicated discrimination of gustatory qualities. Peterson and Rainey (133) classify in terms of discomfort or expressions of comfort. Pratt, Nelson, and Sun (139) found no great differences to the taste stimuli used when the responses were equated with reference to the distilled-water control. During the first few days sucking responses frequently followed all types of stimuli. With increase in age, the sucking reactions decreased to all except the sugar solution. Facial reactions, however, increased to all except the sugar solution.

Sucking responses may be observed in their superficial aspects, but quantitative, objective measurement of the complete sucking response in action is another matter. Thus some of the lip movements which participate in the sucking act occur upon stimulation with salt, sour, or bitter solutions, which also release facial expressions of "discomfort," according to Peterson and Rainey (133). Canestrini notes that all taste stimuli may release the sucking response, and Pratt, Nelson, and Sun (139) argue against differential sucking reactions. Eckstein (54) found differential reactions to taste substances and suggested that taste limens be studied by using the sucking reaction as indicator. Jensen (83) presents evidence of a differential modification of the sucking response to certain taste stimuli. The latter notes that time elapses after actual sucking has begun before the differential reactions begin to appear. It is therefore apparent that the stimulating conditions are not analogous to the previous studies and the pattern of responses investigated is not identical. A further difference consists in the physiological condition of the infant at the time of the experiment. Most of Pratt, Nelson, and Sun's (139) subjects were *asleep* or *quiescent* and, on the average, less than two hours away from the feeding period. Jensen's infants, however, were most of them *awake* and remote enough from the previous nursing period to insure heightened irritability accompanying "hunger" contractions. So it would appear that the results of these experiments are complementary rather than contradictory.

Jensen (83) used mother's milk as a control. Marked deviations of the sucking curves pertaining to the experimental stimuli, from the sucking curves obtained in the control, were termed differential responses. Such responses were consequent to sucking on air and on salt solutions of certain intensities but not to acid milk, glucose, and sterile water. The response is a more sensitive indicator than facial reactions. Partially

"filled" infants are "better discriminators than very hungry or satiated infants."

Canestrini (30) found differential effects in his indices when salt, sweet, sour, or bitter stimuli were employed. "Sweet" stimulation had a quieting effect, whereas the others increased activity in varying amounts.

Technique of investigation. Qualitative studies of facial reactions and preparatory and initial components of the sucking response have been made, utilizing the applicator-stick or medicine-dropper technique of stimulation. Eckstein (54) has made graphic, quantitative studies of the effect of different taste substances through the use of special apparatus. Jensen (83) has utilized an improved manometric system which automatically measures sucking through the "negative pressures" produced by the act.

Summary. The newborn child reacts to taste substances by facial reactions, by differentiation of the sucking responses, and by circulatory and respiratory changes. The facial reactions to salt and some sour and bitter solutions take the form of grimaces and may be accompanied by bodily movements. Eckstein (54) finds characteristic changes in the sucking response for each of the four tastes; Jensen (83), only to salt and air.

5. *Reactions to Thermal Stimuli*

Sensitivity. The effects of limited areal stimulation should be distinguished from those that are due to general environmental temperatures operating upon the receptors or directly altering the activity of the protoplasm of an organism if it be at all poikilothermic. This is a condition which exists during the first few hours because of imperfectly functioning temperature-regulating mechanisms.

Studies of the effects of areal thermal stimulation have been limited in number and unsystematic in execution. Thermal sensitivity was noted by the experimental pioneers, Kussmaul, Genzmer, and Kroner. Preyer (140) determined the critical bath temperature to be about 31.25° C. Chilling or heating of milk results in its rejection, although infants soon learn to accept milk at room temperatures. Blanton (22) observed shivering a few minutes after birth.

Canestrini (30) found immediate and pronounced increases in respiration, brain volume, and restlessness upon application of "cold" stimuli. Peiper (119) confirmed Canestrini's results. Vigorous responses to "cold" stimulation of limited areas of head and leg were observed by Pratt, Nelson, and Sun (139). They also recorded facial and mouth responses to fixed quantities of distilled water introduced into the mouth at temperatures ranging from 8 to 53° C. In their tests, reactions were least to stimuli nearest body temperature; most pronounced to temperatures of 8°, 13°, 18°, and 53° C. Responses occurred in 87 per cent of the cases. Jensen (83) utilized graphically recorded changes in the sucking response as

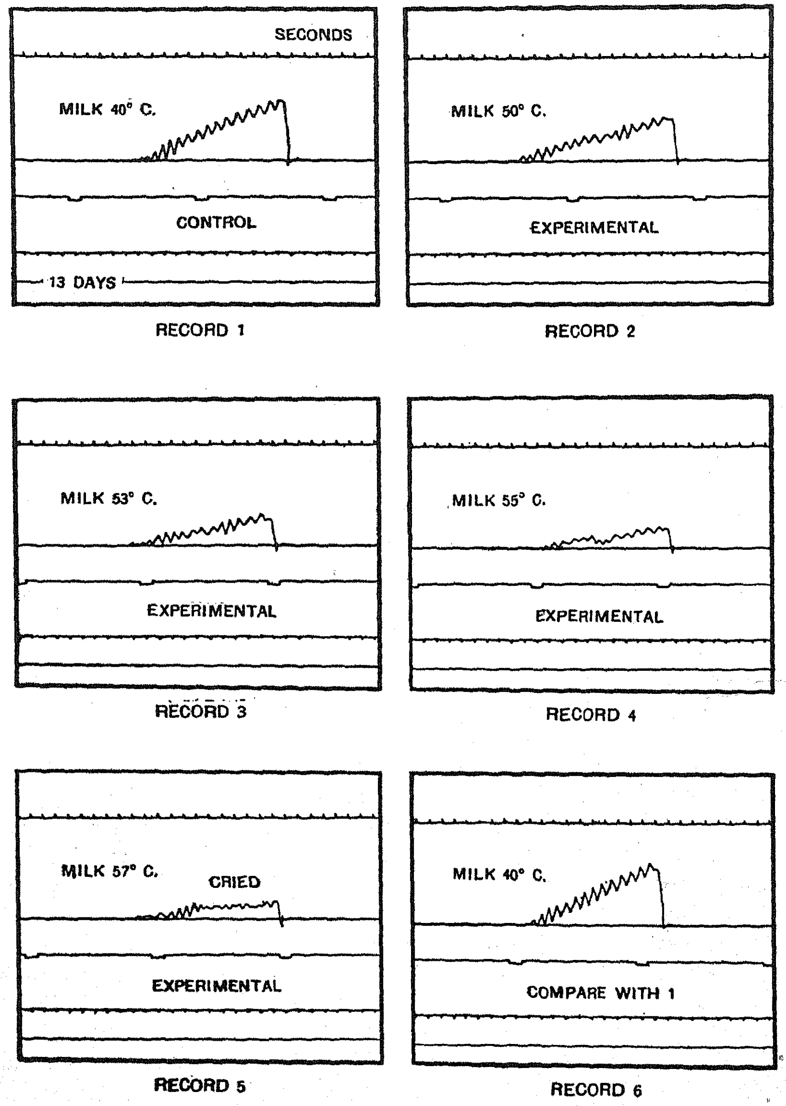


FIGURE 3

Polygraph Records of Differential Sucking Reactions Elicited by Upper Threshold Temperatures

(From K. Jensen's "Differential reactions to taste and temperature stimuli in newborn infants." *Genet. Psychol. Monog.*, 1932, **12**, 425.)

indicators, and found wide individual differences in temperature thresholds, ranging from 5-22° C. as the lower to 50-65° C. as the higher.

Stimuli. Localized stimulation of certain cutaneous areas or of the oral cavity by temperatures below 20° C. and above 50° C. produces pronounced effects. Extensive areal applications at 31.25° C. evoke reactions.

Responses. Areal stimulation of ½-sq.-cm. extent when applied to the forehead elicits reactions in about 70 per cent of the cases. These responses take the form of a throwing-back or withdrawal of the head, with gasping and shuddering next in order of frequency. Similar stimulation of the inner surface of the leg at the knee releases responses in 90 per cent of the cases. Flexion of the leg at the hip is the most common response, with extension of the leg less than a third as frequent, and gasping and shuddering quite rare.

Introduction of limited quantities of distilled water at temperatures of 8°, 13°, 18°, and 53° C. releases "mimetic" reactions, mouth movements, head movements, and squirming, while temperatures nearer the body standard are relatively ineffectual. Jensen (83), contrary to Preyer's (140) results, finds a wide range of tolerance with respect to the effects of milk temperature upon sucking. His results are complementary to those of Pratt, Nelson, and Sun (139) in that their effective stimuli had adverse effects upon the sucking response. Since the effects come only after there have been several sucking movements, the question is raised as to what rôle stimulation of other parts of the alimentary tract may play with respect to modification of the sucking response.

Increases in respiration and in brain volume are reported by Canestrini (30). The reaction-times are short.

Pratt (137) found a low negative correlation ($-.205 \pm .024$) between general activity and environmental temperatures within the experimental chamber ranging from 74-88° F.

Technique of investigation. Objective measurements of the effect of thermal stimuli upon circulation and respiration have been obtained by Canestrini (30) and Peiper (119). Jensen (83) studied their effects upon the sucking response. Peiper (119) devised apparatus to give constant contact stimulation under conditions of varying temperatures. Pratt, Nelson, and Sun (139) constructed thermostatically controlled apparatus in order to maintain their devices at desired temperatures.

Summary. Thermal stimuli that fall below the low and above the high thresholds, which probably vary somewhat according to the body area stimulated, produce vigorous movements of the parts stimulated and of associated segments, affect respiration and circulation, change the character of the sucking response or abolish it, and in some cases cause crying. In healthy newborn infants a few hours old, lowering of the environmental temperature results in shivering and muscular activity (see *Metabolism*), giving a negative correlation between activity and temperature within a limited thermal range.

6. *Reactions to Contact or Pressure Stimuli.* Apart from the study of the reflexogenous areas of particular reflexes such as blinking, lip and sucking responses, plantar and palmar responses, abdominal reflexes, etc., the effects of contact or pressure stimuli upon the cutaneous areas do not appear to have been investigated.

7. *Reactions to Noxious (Pain) Stimuli*

Sensitivity. Needle-pricks upon the nose, lips, and hands of premature infants are reported by Genzmer (65) to have little effect. Similar insensitivity is shown by the newborn child on the first day, but sensitivity slowly increases during the first week. Reaction-times prove to be as long as 2 seconds. The sole of the foot, according to Preyer (140), is the most sensitive area, although the reaction-time (about 2 seconds) is longer than in adults. Canestrini (30) observed relative insensitivity not only to needle-pricks but to faradic and galvanic stimulation.

Increased sensitivity with age is shown by the Shermans' (159) studies in which age in hours was correlated with number of needle-jabs required to evoke the responses. In the stimulation of head areas the range was 6.5 stimuli at 0.5-5.5 hours to 1.7 stimuli at 35.5-40.5 hours, with one stimulation sufficing after 41 hours. In the stimulation of leg areas the range was 10 stimuli at 0.5-5.5 hours to two stimuli at 70.5-75.5 hours, with one stimulus required after 76 hours. From the beginning, a regional difference is thus to be observed.

Stimulation by a controlled needle-prick upon the volar side of the underarm has convinced Peiper (125) that previous notions of great insensitivity to pain stimuli are unwarranted. Premature and newborn infants show sensitivity as well as do older sucklings. The interesting observation is made that, while normal newborn infants are sensitive to pain stimuli, many idiots are quite insensitive.

Stimuli. Needle-jabs have been used as stimuli (noxious) with little control (except in Peiper's work) of the area of application or the amount of penetration. The action of particular stimuli usually assigned to other sensory fields, e.g., stimulation by ammonia and acetic acid as well as intense stimuli in fields such as temperature or audition, is of course unknown in the newborn, although such stimuli may release "pain" responses in the adult.

Responses. The responses take the form of withdrawal of the part affected, facial reflexes (usually interpreted as "discomfort"), general movements, and crying.

The movements have a reaction-time of from 0.12 to 0.70 second with crying coming at from 2-5 seconds or even somewhat later. Peiper (125) notes that these times are comparable to the reaction-times of voluntary movements of the adult.

Technique of investigation. Data susceptible of statistical treatment have been furnished by the Shermans (159). Canestrini (30) has used his usual indices, and Peiper (125) devised an apparatus to apply stimuli of constant value to a specific area. The time of application of the stim-

ulus and the onset of the response (as recorded through apparatus upon which the child's neck rested) were automatically registered on the tape of a Morse-apparatus.

Summary. Even premature infants are sensitive to pain stimuli, although their reaction-times are somewhat longer. Sensitivity seems to increase during the first few days of life, with a clear-cut difference between head and leg areas existing from the first. The responses elicited, with the exception, perhaps, of a higher incidence of crying, present no specific pattern indentifiable as correspondent to the nature of the stimulus. The reaction-times are long, compared with adult responses of an involuntary type. The possibility that marked insensitivity may be useful as a criterion of defect is suggested.

8. *Reactions to Internal Stimuli.* Evidences of the stimulating effect of visceral activity are confined largely to the studies of "hunger" contractions of the stomach, in relation to the generally heightened irritability and to fluctuations in the reflexogenous zone of the sucking and lip reflexes. When substances are introduced into the stomach there is temporary inhibition of the "hunger" contractions; and general quiescence follows the nursing period. After the nursing period, as time elapses general activity is heightened. Although activity may be associated with regurgitation shortly after feeding, micturition (preceded and followed by general activity), and defecation, a regular increase in general activity is correlated with increase in hunger contractions. Taylor (172) has given the best account of the latter, while the periodicity of movements in relation to times of feeding is best shown by Benedict and Talbot's (18) 24-hour graphic studies of the "spontaneous" movements, and by Irwin's (78) investigation of the same by means of the experimental chamber and the stabilimeter-polygraph unit.

9. *Reactions to Movement or Change in Position.* These reactions are reviewed under the head of postural reflexes.

Reflexes

1. *The Sucking Response.* As early as Pepys (132), peculiarities of the reflexogenous zone of this reflex were known. Objective, quantitative studies of the sucking act were made with crude instrumentation by Basch (16), Barth (15), and Pfaundler (134), negative pressures being registered upon manometric or other systems, while the child sucked on a bottle or upon the mother's breast through a special type of nipple shield. Lifschitz, as reported by Bechterew (17), measured sucking movements through pressures exerted by the chin upon a pneumatic system. Eckstein's (54) apparatus enabled him objectively to measure differential sucking responses to taste solutions. The best instrumental technique thus far devised, that of Jensen (83), makes possible the comparison of experimental solutions with mother's milk as a control, and also gives a graphic, quantitative record (see *Reactions to Gustatory Stimuli* and *Reactions to Thermal Stimuli*).

Eckstein (54) found sucking augmented to "sweet" and "sour." Pratt, Nelson, and Sun (139) used the applicator-stick method of stimulation with qualitative observation of mouth and lip movements. They observed that when the responses to experimental solutions were compared with those to distilled-water controls there remained little differential frequency (except possibly that more sucking responses tended to arise from sugar solutions, while citric acid produced far less even than the control). The percentage of sucking reactions to sugar solutions increased with age, but sucking reactions to other gustatory stimuli declined in frequency.

Jensen (83) observed that air and certain salt solutions altered or obliterated the sucking activity, as did milk temperatures above or below certain points. Although "Irwin's 'mass activity' disappears immediately after the nipple of the nursing bottle is placed in the infant's mouth," the sucking may be somewhat disorganized at first, and disorganization again occurs toward the end of the nursing period. When sucking has ceased, stimulation by light, pinching the toe, pulling the hair, or dropping the infant starts sucking anew. He observes that the newborn infant's response to stimulation depends upon what part of the organism is set to respond. It is doubtful, however, whether any activity other than vegetative enjoys such a dominant rôle.

Wolowik (188) observed that electrical stimulation of 4.2 milliamperes would ordinarily release crying in a two-months-old child but that when the child was nursing 14.0 milliamperes were required.

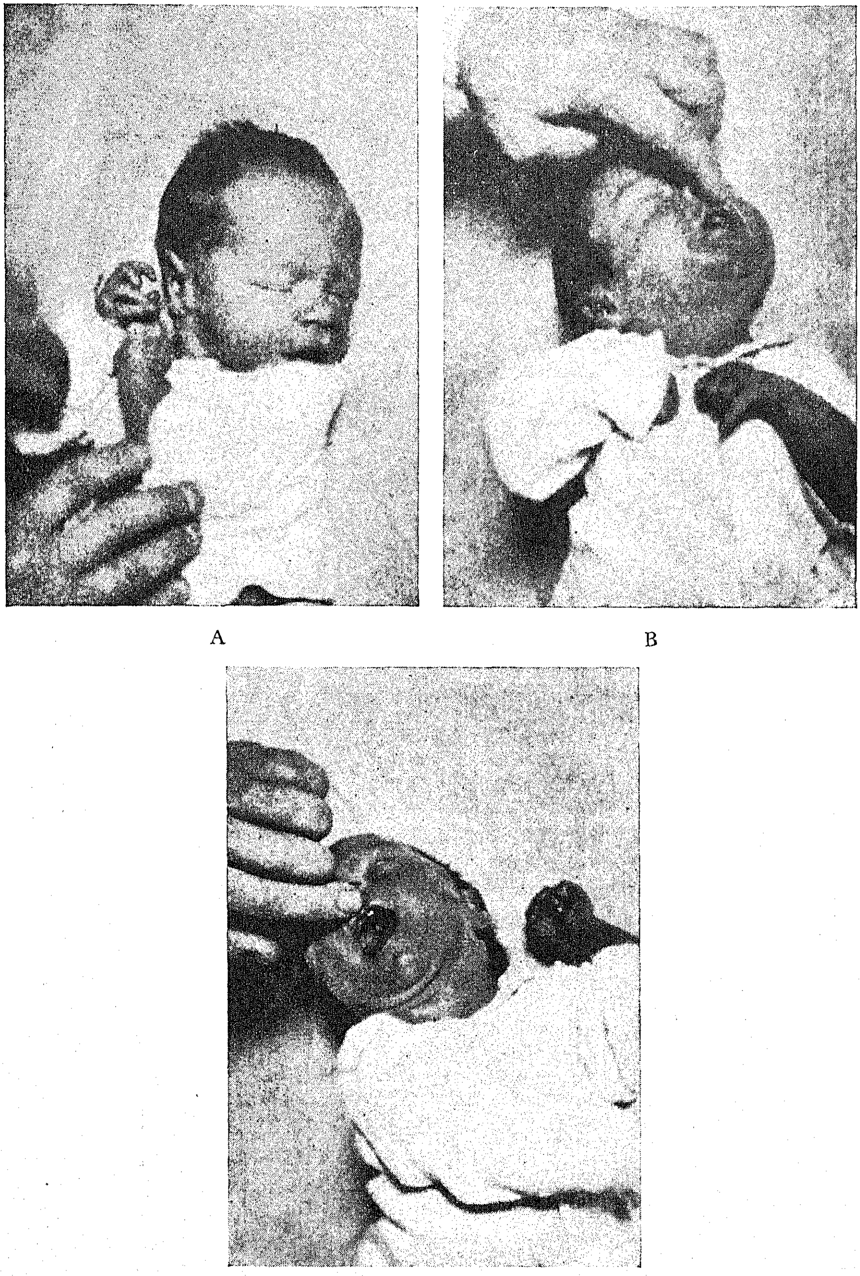
Thomson (175) investigated part of the reflexogenous zone of the reflexes associated with the sucking response. Tapping the surface of the upper lip releases a pursing or pouting. The adaptability of this preparatory action to the contact-aroused erection of the mother's nipple is mentioned. Thomson's reflex has been confirmed by Blanton (22) and by Lambanzi and Pianetta (93), the latter finding it present as a pathological sign in adults.

Cameron (29) and Thompson (174) have discussed the relation of sucking to milk production.

Exploration of the reflexogenous zone related to sucking was undertaken by Pratt, Nelson, and Sun (139). The order from highest to lowest incidence of response is: lips, above lips, below lips, cheek. With increased age, sucking movements to cheek stimulation diminish in frequency.

Although certain aspects of the sucking response (differential responses) are fairly specific from the start, others, e.g., its reflexogenous zone, progress from generalization toward localized specificity. Orientation of head and mouth toward the source of contact occurs when the cheek or areas above and below the lips are stimulated. When the area above the lips is stimulated in a hungry infant the mouth is opened wide, the head thrown back and shaken from side to side, and general activity is heightened (see *Infrahuman Infant*). (See Figure 4.)

2. *The Palmar Response.* The palmar response, a reflex flexing of



C

FIGURE 4

ENLARGEMENTS FROM CERTAIN FRAMES OF MOTION PICTURES OF THE MOUTH, LIP, AND HEAD MOVEMENTS OF AN INFANT TO CONTACT STIMULATION OF THE UPPER LIP

A—before stimulation
B—mouth opened, head thrown back to contact stimulation of upper lip
C—the same, with head moved to side

the fingers in response to contact stimulation of the palmar surface, is commonly termed the grasping reflex. It differs from the neonate plantar response in that the distal segments flex rather than extend. Furthermore, the palmar response disappears within the first half-year, whereas the neonatal plantar response is replaced by the adult type at about the age of walking. In the child, persistence of the grasping reflex is indicative of retardation, according to Wagoner (180). Its return in adult life has pathological significance.

Experimental investigation of the response is difficult because of the characteristically flexed position of the fingers with reference to the palmar surface. The duration and strength of the grasp have been studied by Buchman (25, 26), Mumford (116), and Blanton (22). Human infants may support their weight by both hands for as much as 2½ minutes (see *Infrahuman Infant*).

To Mumford, Buchman, and others this represents a survival movement or partial recapitulation of a response having utility to arboreal ancestors. Givler (68), on the other hand, holds that, though perfected at birth, it may well be practiced before birth and hence not entirely unlearned or innate.

The relation, if any, between this early reflex grasping and the later so-called voluntary grasping is not clear. Mumford's (116) early study of the genetic course of grasping likens the early phases to the simian grasp. Normative studies have been made at the Yale laboratory by Gesell (66) and Halverson (74).

3. *The Plantar Response.* No aspect of infant behavior has received as much attention as the plantar response, although its significance in the life economy of the child is quite trivial, since it has questionable

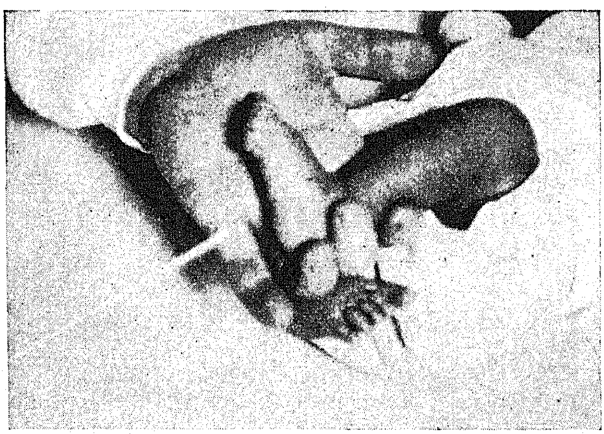


FIGURE 5

TOE REACTIONS OF PLANTAR RESPONSE

Homolateral: flexion
Contralateral: slight extension and fanning *(signe d'eventail)*

utility as a defense reflex and its relation to "stepping" movements is too tenuous for consideration here.

Babinski (7) discovered a pathological plantar response in adults having lesions in the pyramidal tracts. As described by him, this response, as contrasted with the normal adult response of toe flexion, consisted in a pronounced extension of the big toe with extension and fanning of the others *(signe d'éventail)*. Since that time, great confusion in the use of the term "Babinski" has arisen—some applying it to extension of the big toe alone, others to extension of all toes, and some to the total complex of movements originally described by Babinski. This complex is made up of action of other segments than the toes, as, for example, the usual foot and leg flexions.

Early studies of the plantar response in newborn infants seemed to indicate that the Babinski complex is physiological at this period. Such findings were reported by Leri (100), Engstler (57), and many others. Some, however, such as Feldman (59), Engstler in prematures, the Shermans (159), and others, found a higher percentage of toe flexion. Still others found such difficulty in obtaining specific responses or obtained such variability of response that they question the advisability of the term "plantar reflex." Exponents of this view are Burr (28) and Wolff (187). Minkowski (110) discovered flexion to be the rule in the fetal stage, as did Bersot (20). Following this, Lantuejoul and Hartmann (98) found the flexion response to predominate in the first few hours after birth. Babinski (8) and his associates obtained the same results.

Bersot's (20) exhaustive study of this reflex at all stages of life shows, as do the investigations of Collier (43), that the Babinski type gives way to one of normal plantar flexion at about the age of walking. Persistence of the Babinski sign is associated with other retardation according to Collier (43) and Engstler (57).

Collier (43) states that even up to twelve years the Babinski sign may be elicited in sleep.

Rudolf (149) traces parallel phylogenetic, ontogenetic, and pathological changes of the plantar response. Feldman (59) reports sex differences, and Bryan (24), race differences.

Usually the Babinski sign in newborn infants has been interpreted to indicate incomplete myelinization and functioning of the pyramidal tracts, but, in the light of Minkowski's (110) and Bersot's (20) success in eliciting the plantar flexion in the fetal stage and Lantuejoul and Hartmann's (98) and others' finding the same at birth, this interpretation must be questioned.

In the neonatal stage Bersot (20) states that the response is generalized both as to cutaneous receptor areas and as to effector segments innervated. This view is supported by Pratt, Nelson, and Sun (139), who in their research employed a stimulating device which gave a fairly constant pressure during the stroking contact along the median line of the sole of the foot.

Moro's Clasping (Umklammerung) Reflex

Moro (114), Freudenberg (63), and Schaltenbrand (152, 153) have described a response pattern to jarring, quick change of position, etc., which, with the exception of lack of the palpebral component, is essentially the same as the major pattern of the auditory response. Moro (114) regarded it as an atavistic phenomenon harking back to an arboreal stage of existence. He also noted (115) that its persistence beyond the early neonatal period was associated with other retardation. Peiper observes that this is essentially the so-called "fear" reaction.

Cutaneous Protective Reflexes

Galant's *"Rückgrat"* reflex and certain abdominal reflexes consist of a bowing of the cephalocaudal axis so that the cutaneous area stimulated by a stroking contact is removed from stimulation. A reflex having similar protective effects has been observed by every small boy when he has tickled one of the lateral abdominal surfaces of the common toad.

Postural Reflexes

Postural reflexes of various types have been observed. The characteristic flexion of the arms at the elbows and of the legs at the knees has been variously explained, according to Hutinel and Babonneix (77), in relation to fetal postures, to relative weight and development of extensor and flexor muscles, and to neural innervation. Ritter's (146) measurements incline him to accept the latter.

Lifting of the head and shoulders when the infant is placed in a prone position has been observed by Bryan (24) and Shirley (161), and other similar postural reflexes involving static sensitivity have been reported by Peiper and Isbert (131). The inhibitory effects of swinging or rocking upon crying are too well known to need comment. A nystagmus arising from the stimulation of static receptors through rotation of the infant rather than from visual stimulation was investigated by Bartels (14) and Alexander (3). During rotation there is no rotation nystagmus but after rotation ceases after-nystagmus occurs for about 15 seconds. The head is moved in the direction of rotation during rotation and in the opposite direction afterwards.

Galvanic Skin Reflex

During the first year of life Peiper (120) found this reflex impossible to elicit.

Emotions

Just as mental content in the form of sensations has been ascribed to the young infant on the basis of reflex activity that is produced by sense-organ stimulation, so has it been endowed with "emotions" on the basis of "expressive" movements. Thus its "mimetic" responses to many types

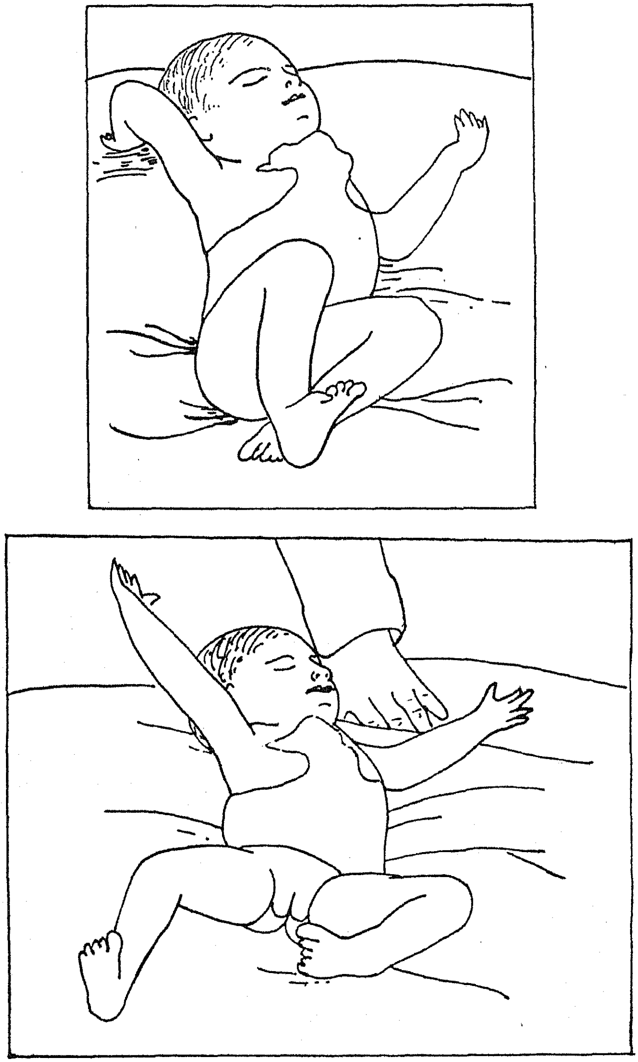


FIGURE 6

MORO'S CLASPING REFLEX

Sketches of two photographs of the posture of an infant before stimulation and of the response known as Moro's clasping reflex following stimulation by jarring. The photographs are to be found in G. Schaltenbrand's "Normale Bewegungs- und Lage-reaktionen bei Kindern." *Dtsch. Zsch. f. Nervenhk.*, 1925, **87**, 23-59.

of stimuli such as auditory, gustatory, olfactory, etc., have been interpreted to mean "disgust," "comfort," "discomfort," and "pleasant" and "unpleasant," etc. Watson (182), himself opposed to such interpretations and to the liberal endowment of the infant with complex innate modes of response, nevertheless differentiates between three alleged "primary emotions," i.e., three complex innate patterns of overt behavior. They are: (*a*) fear, consisting of "a sudden catching of the breath, clutching randomly with the hands (the grasping reflex invariably appearing when the child is dropped), sudden closing of the eye-lids, puckering of the lips, then crying," which is released by removal of support, loud sounds, jars, or shakes; (*b*) rage, consisting of crying, screaming, stiffening of the body and "fairly well-coordinated slashing or striking movements of hands and arms . . . . the feet and legs are drawn up and down; the breath is held until the child's face is flushed," this being released by hampering movements, holding of the head or holding of arms to the infant's sides; (*c*) love, "cessation of crying, smiling, attempts at gurgling and cooing released by stimulation of some erogenous zone, tickling, shaking, gentle rocking, patting and turning upon the stomach across the attendant's knee."

Sherman (157) performed the crucial experiment of presenting motion pictures of activity in newborn infants with and without the stimuli which evoked them being known to a group of medical students, nurses, and elementary and advanced students of psychology. To a particular set of infant responses little unanimity was found among the verdicts—over twenty different emotions being assigned with little agreement even within a specialized group. When the stimuli were shown with the responses the agreement among observers became greater, particularly among medical and elementary students. This series of investigations reveals that in differentiating emotional states in newborn infants knowledge of the stimulus plays an important part.

Pratt, Nelson, and Sun (139) studied the effects of restraint of movement of the arms, these being brought down and held firmly but gently against the body. This is the Watsonian stimulus for "rage." *In 358 experiments upon 66 infants the passive state was maintained 58 per cent of the time, i.e., hands and arms remained where placed after the experimenter's hands were withdrawn; in 26 per cent there was a brief period of activity which gave place to inactivity; in 13 per cent the arms immediately flexed again or there were other signs of activity; in 3 per cent a brief period of quiet was followed by activity.* Restricting movements of the arms is not followed by the pattern of response called "rage." It has for the most part a quieting rather than excitatory effect. Even with the limited restriction afforded by a sleeveless gown the general activity of the rest of the body is cut down.

The question may well be raised whether there are any innate "emotional" responses, according to Dashiell (49). If "emotion" is to mean much when applied to measurable, observable activity it must apply to

other than transitory reactions; as a "stirred-up state of the organism," an emotion must last an appreciable period of time. Watson defines an emotion as "an hereditary pattern reaction involving profound changes of the bodily mechanism as a whole, but particularly of the visceral and glandular systems."

A study of the reactions of infants to auditory stimuli reveals a group of reflexes, palpebral, general jerk of trunk, and extension and abduction of arms and legs, which, as Peiper (123) observes, are to be identified with the pattern of responses evoked by other types of stimuli and known as Moro's *Umklammerung* reflex. Except with intense stimuli crying does not occur nor do sleeping infants awake. The response has a fairly quick reaction-time and is of short duration. The effects of activity in the autonomic system, such as circulatory and respiratory changes, are also of short duration. The Moro component appears with successive stimulation but declines in extent and may be restricted to toe movements or be abolished altogether.

The same may be said of the responses to so-called "anger"-evoking stimuli. The responses, if any, are of quick reflexive character.

Sustained, heightened activity in newborn infants appears to be correlated with activity along the alimentary canal, particularly the stomach, and with certain environmental temperature ranges. There seems, therefore, to be little utility in the term "emotion" as applied to the behavior of newborn infants. That the palpebral reflexes and parts of the Moro reflex may be present in later "fears" is not denied, but to label them "fear" seems pointless.

SLEEP

The criterion for sleep in infants is none too satisfactory. If the child's eyes are open, it is said to be awake; if they are closed, it is asleep. The sleeping state, thus defined, is associated with the quiescence following nursing, and disappears as the next feeding period approaches. To say, as Czerny (47) does, that the depth of sleep is more profound in newborn infants than in older individuals, because stronger electrical stimuli are necessary to arouse them, is not equivalent to saying that we are measuring sleep. If our analysis of the neonate organism is correct, it merely means that when the stomach is filled the organism usually shows less irritability, the closing of the eyes having trivial significance.

The inhibition of gastro-intestinally aroused general activity facilitates the study of reactions to specific stimuli even though irritability be not as great. It is significant that almost all studies of infants have been made under this condition. Pratt, Nelson, and Sun's (139) tables show some of the differences in response to the same type of stimulus under the conditions "awake" and "asleep." Observations of some visual responses have been hampered, as McGinnis (106) shows, because infants whose eyes are open are usually in such activity that successful study is impossible.

Comparison of the "spontaneous" activities of newborn infants under

the conditions "awake" and "asleep" have been made by Pratt, Nelson, and Sun (139), and Irwin (78) has been able to follow these through the entire day rather than in a limited sampling. Effects of stimulation upon the autonomic system during the sleeping state have been made by Peiper (121).

Although most reflexes are easily evoked in specific forms in sleep, some appear best during the waking state, as, for example, the sucking and palmar responses.

Pratt, Nelson, and Sun's (139) figures show that the amount of time the newborn child is awake and moderately quiescent is very limited.

Learning

Casual observation seems to indicate that the postnatal environment rapidly modifies behavior. Particularly is this true in relation to the feeding (Ripin, 145) and care of the baby. Reactions of the infant, especially crying, are potent stimuli for adults, leading them to take action with reference to the source of stimulation. This mechanism assures attention to certain basic needs of the child but also facilitates the formation of undesirable habits.

Feldman (58) states that when a night-feeding period is eliminated the child at first wakes up or shows greater activity at the usual time of feeding. Very soon, however, the infant sleeps during most of the night. May this adjustment be termed "learning"?

The Russian school of physiologists has maintained that conditioned responses cannot be established below the three-to-five-months level in the human infant. Marquis (105) claims that the sucking response may be conditioned to auditory stimuli within the first ten days and, accepting the myelinogenetic law, holds that the process is effected at subcortical levels. Ten infants were studied. Of these two served as control and all except one of the rest were successfully conditioned. Starting at the end of the first 24 hours, the infants were bottle-fed six times per day. Before introduction of the nipple in the child's mouth a buzzer was sounded for 5 seconds and for a similar duration afterwards. During the feeding period the nipple was withdrawn several times with repetition of the procedure just outlined. Objective measurements were obtained through polygraph records of the sucking response as registered through apparatus attached below the chin.

By the fourth day conditioning made its appearance, taking the form of decrease in crying and general activity and increase in opening of mouth after sounding of the buzzer. By the fifth day there was an increase in sucking movements. The control did not show such responses.

Suggestive as is this pioneer work, the experiment is not crucial. Auditory stimuli may have inhibitory effects upon already existing activity without any process of conditioning. This is particularly true if the stimulus be of some duration. This invalidates the inference drawn from the differential effects of auditory stimuli produced by buzzer and fall-hammer.

Furthermore, the onset of this "conditioning" at the fourth or fifth day may only mean less auditory sensitivity up to that time. On the positive side, however, there is the increase in opening of the mouth and in sucking movements—a trend contrary to the usual increasing specificity of all aspects of the sucking response.

Discrimination between behavior modifications based upon maturation and those arising from learning is not easy. Coghill (42) has called attention to the fact that the same sequence of change is seen in establishing a conditioned response as in the development of unlearned behavior, namely, an initial generalized response with respect to stimulus, receptor and effector aspects then changing to the more specific and localized. The effects of learning are much more apparent when the end-result consists in attaching an initially specific response to a wide variety of stimuli originally ineffective. This is quite conspicuously the case with salivary secretion.

The Nature of the Neonate Organism

1. *The Neonate as a Man in Miniature.* From the layman's point of view, the newborn child is regarded as a kind of man in miniature—not, it is true, as a dwarf, but as a smaller edition of the adult, as yet deprived of the powers of speech and locomotion, and the ability effectively to manipulate his surroundings. The adult says of the infant, "If he could talk he would say this," "If he could he would do this," or "He wants to do this or that."

The future adult behavior is foreshadowed with varying degrees of detail. Literary expressions of this view interpret quite common behavior as having peculiar significance. Thus Rolland, in *Jean Christophe,* sees the future musical ability of the individual indicated when the babe ceases crying as the chimes sound. Subjective approaches to the analysis of child behavior, as exemplified by Piaget (135) who attempts to reconstruct the neonate "mind" as essentially egocentric and striving to preserve interesting conscious experiences, are little removed from ordinary literary speculation.

The popular view, like the old theory of the "homunculus," fails to evaluate properly other than the growth-in-size aspect of development.

2. *The Neonate as a Recapitulation.* With the Darwinian conception of the descent of man there arose the doctrine that in embryological development previous phylogenetic stages are passed through in evolutionary order. This developmental concept was extended by zoölogists to the phenomena of postnatal development, and some child psychologists, notably Hall and his school, applied it to the appearance of certain so-called "instincts" emerging during the period of childhood.

The character of the grasping reflex of the newborn infant has been cited by Buchman (25), Mumford (116), and others as evidence of the simian ancestry of man; while to Moro (114) the *clasping* reflex *(Umklammerungsreflex)* is proof that man's ancestors were arboreal.

In Davidson's (50) able review, the evidence supporting the doctrine of recapitulation is critically appraised with the conclusion that the phylogenetic series is not really repeated. Some stages are not repeated at all while others are telescoped or otherwise modified. This denial of a precise recapitulation in no way invalidates the basic formulation of the essential relationship of animals. The brief survey under the head of *"Infrahuman Infant"* presents startling resemblances in the early stages of mammalian development.

3. *The Neonate as an Organism Developing Autonomy.* The neonate is an organism in the process of developing a relative autonomy with respect to its physical and social environment. At birth the individual obtains a more unrestricted and richer environment. He achieves his own respiration, carries on digestive activity, and excretes waste products. At first the environment succeeds in lowering his body temperature, but soon, through muscular activity and crying, a regulating mechanism becomes manifest. In addition to these means of raising his temperature, the infant's cries move the social environment toward the same end. In similar fashion, the great activity and crying accompanying "hunger" contractions act upon the social environment to provide food. The social environment is also manipulated with respect to effecting the removal of certain noxious stimuli and of attending to the consequences of excretory functions. The same neonate-produced stimuli soon procure for it fondling, caressing, etc.

Even *in utero* mechanisms for adapting to environmental situations or of inhibiting reactions appear (see *Reactions to Auditory Stimuli*).

And the growth processes themselves, according to Gesell (67), limit the amount or type of modification which can be effected by the environment.

At first the effective manipulation of the environment is accomplished through the social environment as intermediary, but as random activities are replaced by "voluntary" movements a whole series of direct manipulations take place. The mechanisms underlying this change deserve study. They seem, however, to be bound up with the development of differentiated, specific responses and the appearance of particular coordinations as, for example, those of the eye and hand. According to Dearborn (51), voluntary movement depends upon the development of an inhibitory mechanism already present in the newborn child. Rowe (148) goes on to report that, in adults, establishing "voluntary" control of muscles ordinarily participating in a complex requires a singling out of the kinaesthetic component for that particular muscle group. It thus represents a development toward specific, localized responses from a previously generalized response.

4. *The Neonate as a System of Reflexes.* Virchow, according to Cruchet (46), is responsible for the conception of the neonate as a purely spinal being whose behavior is likened to that of a decerebrated frog. Reflexes, even when extensively coordinated, or difficult to elicit because

of general activity, are regarded as simple defense or avoidance reactions, these terms being used with little precision. Detailed analysis of particular so-called defense reflexes reveals that the teleological aspects are incidental rather than intrinsic.

Certain innate patterns of response, variously termed "emotions" and "instincts," appear, but these are limited in number according to Watson (182). Further development of behavior depends upon the linking-up of the specific discrete reflexes and of the primary emotional patterns with other than the originally adequate stimuli. The environment acts to integrate the separate, part activities into coordinated wholes.

The view that the neonate is purely a "spinal being" is denied by Peiper (130) on the basis of the ability to inhibit responses to successive auditory stimuli; while Kroh (89) believes that certain aspects of the sucking response indicate "memory," an activity not to be ascribed to a purely "spinal being."

5. *The Neonate as a Developing Organism.* The neonate may be said to be a generalized type of organism in that it has few responses which are called forth by one modality of stimulus alone, or that arise from stimulation of a particular receptor area, and which are themselves localized in specific effector segments. The direction of development, as Minkowski (110), Bersot (20), Pratt, Nelson, and Sun (139), Irwin (78), and Pratt (137*a*)[5] have shown in early human stages, and Coghill (38, 39, 40) and others, in lower animals, is in the direction of the individuation of specific movements from the generalized movements of the organism as a whole or in some major segment in the initial stages of development to localization or limitation within a given segment.

The "spontaneous" movements, undetermined by external stimulation, cannot properly be termed the original matrix (78, 79, 80) from which individuated behavior arises since these movements have been shown to arise largely from gastro-intestinal activity (see *Alimentation* and *Sucking*). It seems probable that activity of the digestive tract brings into play most of the behavior mechanisms which have thus far developed. Just before the feeding period activity may be observed in all segments of the extremities, the musculature of the trunk is active in squirming movements, the child's face is flushed, and crying is rhythmical in character.

During the establishment of a conditioned reflex, as Coghill (42) has pointed out, the same order of generalization, then specificity, appears. But the net result of the conditioning process may consist, in many cases, of generalizing a response which previously was specific on the stimulus side (see *Physiology* and *Learning*).

Regional development of motility, as Coghill (38, 39), Langworthy (97), and others have shown, proceeds cephalocaudally and proximo-

[5]A paper presented by the writer before the American Psychological Association at Toronto, September, 1931.

distally. This has been shown to apply in humans by Irwin's (78) and by Shirley's (161) longitudinal studies of human development.

The doctrine of development from fundamental to accessory movements as expounded by Buck (27), Moore (112), and Shepardson (156) is a forerunner of the present idea that development proceeds proximodistally. In education it has referred to the progress from control over larger muscles to coordination of smaller muscles. Thus the progress is from voluntary control of larger muscle groups to voluntary control of smaller muscle groups. As Johnson (84) notes, however, it is a mistake to assume a separation in time, for actually both types of control progress together.

At the present time it does not seem possible to correlate these changes satisfactorily with neural change such as myelinization or to evaluate the conflicting claims of "maturation," as supported by Carmichael's experiments (32, 33), with the "standard environment" as postulated by Child (37), on the other.

Conclusions

The alimentary canal plays a dominant rôle in the activity of the neonate. When "hunger" contractions of the stomach begin, the irritability of the child increases; with the mounting vigor of each successive period of stomach contraction the general activity spreads so that almost all of the musculature of the body is in action. Initially intermittent, feeble crying becomes continuous and intense. At this extreme height of activity very few stimuli act to inhibit or quiet the child. In a very small percentage of the cases auditory stimuli are momentarily effective. Swinging or rocking is much more efficient, but when such stimulation ceases the general activity is not long in reappearing. If the cheek or lip areas are now stimulated the head quickly turns toward the source of stimulation. If the area above the lips is stimulated the head moves from side to side and back, the mouth opening wide.

The child, put to breast or bottle, shows some disorganization of sucking but soon performs with regularity and precision. The general activity disappears. If one now stimulates the organism the ordinary consequence is some modification of the sucking act. Potent stimuli are required to cause the child to cease feeding if the food substance be mother's milk or an accepted substitute. As the stomach fills, the sucking becomes irregular, less vigorous, with long periods of quiescence. During such a period of quiescence almost all types of stimuli such as dropping, a flash of light, pulling hair, etc., lead to renewed sucking.

The feeding act over, the infant lies quiescent and asleep. At this time, although irritability is not as great, it is possible to observe the effects of different stimulus modalities. Variable patterns of response appear, some presenting considerable specificity with respect to stimulus-receptor-effector relationships. In other instances the response may be generalized, involving most of the body or some gross segment thereof.

During the quiescent period regurgitation, excretory activities, etc., may be accompanied by short periods of activity. If, in consequence of one of these, thermal stimulation through evaporation should arise, again activity may occur.

The newborn infant presents tremendous possibilities for development through "maturation" and through "learning," but is not as helpless and ineffectual an organism as it is usually portrayed. The vocal apparatus, although perhaps not producing specific crying, when exercised, leads to activity on the part of surrounding adults. And that activity provides food and care and even the removal of certain noxious stimuli.

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CHAPTER 4

MATURATION AND THE PATTERNING OF BEHAVIOR

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Maturation is a term which has recently come to the fore in the literature of child psychology. It is not a precise and altogether indispensable term, but it has come into usage as an offset to the extravagant claims which have been made for processes of conditioning and of habit formation. In spite of some inevitable vagueness, the concept of maturation may serve, at least for a period, as a useful aid both to experimental investigation and theoretical interpretation. We shall attempt in this essay to indicate the rôle of maturation in the early patterning of child behavior, and to consider briefly the related concepts of heredity, environment, learning, growth and development.

If we manage to envisage maturation as an active physiological process, we overcome the rather stilted antithesis of the nature-versus-nurture problem. Galton tells us that in his day the very term *heredity* was strange. With the advent of Mendelism the term took on popularity and became oversimplified. Individual unit characters of inheritance were too specifically identified with discrete chromosome particles, and heredity came to be regarded too mechanically as a fixed mode of transmission. Geneticists now emphasize the fact that these particles are chemicals which interact with each other and with many other factors to produce the organism. And if we but knew the biochemistry and biophysics of the interactions we should be making much less earnest use of such words as *heredity, environment,* and *maturation.*

CONCEPTS OF DEVELOPMENT AND ENVIRONMENT

The heredity and environment of an organism can be completely separated only in analytic thinking, for in actual nature such separation would lead to instant death of the organism, even though the philosopher making the analysis might himself survive. Life depends upon "extraneous" factors like ultra-violet rays—rays which would become lethal if not filtered by the earth's thin layer of ozone. Life is dependent upon combined or fixed water of crystallization, often on free water, and on carbonic acid. L. J. Henderson (24) has dwelt both scientifically and philosophically on the peculiar fitness of the inorganic world for life. There is a "fitness of environment" which is quite as impressive as the fitness of organisms. Development cannot be understood unless both forms of fitness are coordinately recognized. "Just because life must exist

in the universe, just because the living thing must be made of matter in space and actuated by energy in time, it is conditioned. In so far as this is a physical and chemical world, life must manifest itself through more or less complicated, more or less durable physico-chemical systems."

Development is a process in which the mutual fitness of organism and environment is brought to progressive realization. This process may be thought of mystically; but, scientifically, it is a series of biochemical, morphogenetic events: a process of continuous differentiation, "coordinated in time and place, leading to specific ends." It is unnecessary to draw an absolute distinction between physical and mental developments. "They" occur in close association and may be considered basically unitary. Both express themselves in changes of form and of patterning which may be investigated from a morphological standpoint.

Likewise it is unnecessary, and even undesirable, to insist upon a distinction between growth and development. We shall use these terms interchangeably and make them equally applicable to mind and body. In proper context the word *growth* may be used to designate augmentation or increase instead of differentiation of structure and of function. This, however, represents a purely analytic concept because all organic growth actually involves changes in configuration and organization. Growth always produces alterative as well as magnitude changes.

Mental growth (or development), therefore, is a progressive differentiation and integration of the action systems and behavior patterns of the total organism. Without implying any dualism, it is suggested that mental growth, like physical growth, is a process of morphological organization.

The term *maturation* also is equally applicable to mental and physical phenomena. Maturation is the intrinsic component of development (or of growth) which determines the primary morphogenesis and variabilities of the life-cycle. Although the word *growth* is sometimes loosely used as synonymous with maturation, the former is the more comprehensive term including all the developmental differentiations of the organism in response to external as well as internal environments.

Learning, in a psychological sense, may be regarded as that aspect of growth (or of development) which is a functional perfecting of behavior adaptation to specific situations present or past. Thus defined, there is a distinction between maturation and learning which may be applied in the study of problems of child development. Experimentally, it is difficult to demonstrate the distinction because growth itself is a highly unitary process which depolarizes the two opposing categories of heredity and environment. Growth is not an easily dissected function in which elements of inheritance are readily distinguished from factors of environment or of training. The constitution and conditions of the organism are intimately interdependent. The organismic pattern of one moment, responsive to both internal and external environment, influences the pattern of succeeding moments. In a measure previous environmental effects are perpetuated by incorporation with constitution. Growth continuously contributes to its own conditions.

It is subject to the regulatory influence of the very products of growth. Present growth hinges on past growth.

Accordingly there is a very reciprocal interrelationship between heredity and environment. The intimacy of this relationship may not, however, prevent us from ascribing a priority and possibly even some preponderance to hereditary factors in the patterning of human behavior. Although it is a truism, it should be emphasized that no environment as such has the capacity of growth. Environmental factors support, inflect, and modify, but do not generate the progressions of development. Growth as an impulsion and as a cycle of events is uniquely a character of the living organism and neither physical nor social environment contains any architectonic arrangements even analogous to the mechanism of growth.

The Growth Cycle and Genes

And where does this growth cycle of events have it source? We shall briefly consider some of the biological facts which underlie the development of the human embryo; because the rôle and the manner of maturation in the shaping of the individual are foreshadowed in the earliest genetic stages.

It seems that the first ground plan of the body is due to the mother alone. In certain animals in which the cytoplasm carries coloring matter, the first steps in the development of the egg, prior to fertilization, have been minutely followed. The nucleus, consisting of chromosomes, which in turn consist of genes, enlarges by taking fluid from the cytoplasm. The membrane of the swollen nucleus (or germinal vesicle) dissolves and fluid passes into the cytoplasm. These physical and chemical interactions between nucleus and cytoplasm constitute a fundamental process of development. They take place at every subsequent cell division, in the millions of individual cells which comprise the organism (31).

But in the single-cell stage, the entire interior of the ovum is observed to transform, to rearrange itself, to take on a definite structure. Three zones corresponding to the outer body, the alimentary canal, and the skeletal and other parts of the organism define themselves, "the first visible diversities produced in development." It is a remarkable fact that the foundation plan of the individual is thus laid down under the influence of the mother's genes only. This reflects the indigenous nature of the original growth potency which has already been emphasized. Do the genes ever lose a control in the patterning of the organism?

With fertilization, half the genes from the mother (one from each pair in the chromosomes of the ovum) are lost and replaced by corresponding genes from the father. Egg (the maternal gamete) and sperm (the paternal gamete) combine to form the zygote which becomes, or indeed already is, the individual. This individual grows by cell division and cell differentiation, passing through a continuum of phases which together constitute the life-cycle: the germinal, embryonic, fetal, and neonatal phases, followed by infancy, childhood, adolescence, maturity, and senescence. In this inescapable succession of life-stages we have the broadest expression of

maturational factors. It must be remembered that the genes do not find lodgment in the reproductive cells only but in all the somatic cells. Into each cell of each tissue and of every bodily organ go appropriate subdivisions of both paternal and maternal genes. These ancestral genes are found in every neuron. They produce, as well, the hormones which secondarily regulate development at all ages, prenatal and postnatal. It is these genes which are the focal sources of directive and constructive energy. They interact with the cytoplasm which is always influenced by intracellular and extracellular environment; but the primary physiological factor in this interaction traces to the gene. To this degree the genes always figure in the physiology of development from the moment before conception to death. Moreover, Morgan (38) has suggested that every gene affects the entire organism. Surely they must contribute substantially to the determination of individual differences—not excluding behavior differences among children and men.

Are these genes more than a hypothetical formula? They are realities. They are too small actually to be seen by the ultramicroscope; but by experimental methods as many as fifty have been identified in one chromosome of the fruit fly. Maps have even been drawn up showing the relative positions of such genes in the chromosome. Estimating the number of genes through the mutations produced by X-rays in thousands of flies, the total number in one cell is said to be not less than 14,380. The size of a single gene measures about one-quintillionth of a cubic centimeter, or the equivalent in volume of fifteen protein molecules.

In these myriad genes we have an ample basis for the operation of maturational processes throughout the whole life-span of the individual, including infancy. The genes should not be thought of as little eugenic packets which determine hereditary characteristics prior to birth. They should be thought of as the biochemical agencies which constantly participate in the complex physiology of both prenatal and postnatal development.

The Experimental Analysis of Development

The knowledge of the nature of this complex physiology is increasing at a significant rate. Three monumental volumes on chemical embryology have appeared (39) and there is a stupendous literature in experimental embryology which deals especially with the mechanisms of growth regulation—investigations of symmetry, size, form; the effects of light, heat, cold, gravity, and chemical solutions, and irradiations.

The surgical analysis of the problems of morphogenesis has been especially ingenious and revealing. The same methods used on human beings would produce Frankensteins, but the methods may be safely used with lowly organisms like the sea urchin and salamander. Fragments of the growing organism are accurately destroyed, or removed from one part and grafted into another. Limbs of the salamander are transplanted to grotesquely inappropriate regions of the body. An embryonic eye is shifted to an abdominal position to determine the ability of the rudimentary

optical cells to induce the growth of a lens in surrounding tissue. A section of the embryonic spinal cord may be transected at two levels, lifted out, reversed, and replaced in position to determine whether the growing part recovers its proper orientation or polarity. Presumptive ectoderm may be grafted into mesoderm and vice versa. Tissue cells may be removed completely from the organism to be grown in the monastic isolation of tissue cultures. The cells of the embryo of one species may be lifted to fill a surgical cavity created in the protoplasm of a foreign species. The presumptive mouth of a newt may be substituted for the presumptive mouth of a toad, and so forth. And the tendency of growth to achieve expression is so powerful that an amazing array of these surgical manipulations are experimentally successful.

Although these investigations in experimental embryology are concerned with the biological environment of laboratory organisms, the mechanisms revealed throw suggestive light on the psychological problem of maturation. It has been shown that organic growth does not proceed in an absolutely predetermined and stereotyped manner. By transplanting just the right amount of embryonic tissue, at just the right time, to the right position in the body of a growing salamander, a potential eye may be converted into a gill or a gill into an eye. The conditions of surrounding tissue affect the fate of the growing part. But if the transplant is made at a later stage, the potential eye, truer to itself than to the strange surroundings, becomes an eye even on the abdomen.

There are groups of cells (in the salamander they lie within the dorsal lip of the blastopore or embryonic mouth) which have the peculiar power of directing the differentiation in neighboring cells. Such a cell group, called an organizing center, regulates the directions of development and the map of differentiation; but the cells once differentiated remain true to their chromosomal composition. Species characteristics persist. If the leg of a salamander of Species A is grafted into the body of a salamander of Species B, the transplanted leg develops according to Species A and does not transmute into B. If the developing egg of a mammalian Species C is transplanted to a foster mother (Species D), the egg does *not* take on the constitutional characteristics of Species D. In sum, although the experimental analyses of development have demonstrated at every turn the responsiveness of the growth complex to external and internal conditions, these studies have also shown the existence of a profound stabilizing mechanism which regulates the degrees and the modes of the plasticity and limits the final manifestations of growth.

The Structural Basis of Behavior Pattern

In the notable investigations of G. E. Coghill (8, 10), the embryonic development of the nervous system of the salamander (*Amblystoma punctatum*) has been charted in minute detail. These studies have correlated the anatomical and physiological aspects of growth in a way which throws

light on the most general principles of behavior patterning. A major conclusion is formulated as follows:

> "Behavior develops from the beginning through the progressive expansion of a perfectly integrated total pattern and the individuation within it of partial patterns which acquire various degrees of discreteness.
>
> "The mechanism of the total behavior pattern is a growing thing."

The nervous system dominates, integrates, and elaborates this pattern through processes of growth. But even before the embryo of the salamander has a nervous system it is a perfectly integrated organism. Its processes of tissue growth are coordinated and progress in an orderly manner under the regulative influence of organizing centers, metabolic gradients, and gradients of electropotential. Longitudinal sensory and motor tracts are the first to emerge from these gradients while other parts of the nervous system are still in an embryonic, preneural stage of development. The nervous system controls the total behavior pattern as this pattern expands; but the preneural system of integration overlaps the neural; and individual neurons; including motor neurons, grow in an embryonic manner long after they are already functional conductors. These growth relationships, demonstrated by actual microscopic studies, give solid content to the concept of maturation.

The function of the nervous system is to maintain the integrity of the organism. The nervous system grows according to its own intrinsic pattern and thereby establishes the primary forms of behavior. These forms are not determined by stimulation from the outside world. Experience has nothing specifically to do with them. Coghill has shown that the primary nervous mechanism of walking (in the Amblystoma) is laid down before the animal can at all respond to its environment. Similarly, the sense-organs are the last elements of the vestibular system to maturate.

> "The central relation of the neurones of the postural mechanism must therefore be determined without reference to the peripheral stimulation of the sense organs concerned. . . . The pre-sensory growth of the cerebral mechanism may accordingly be regarded as determining what the attitude of the individual as a whole shall be toward the environment before the organism can take cognizance physiologically of its environment."

The primary attitude of the organism and the initiative of attitude are thus intrinsically determined.

Behavior, however, is not stereotyped even in the Amblystoma. Experience has much to do in determining when and to what extent performance will take place. To provide for this "conditioning" of behavior, there is a working capital of supra-sensory and supra-associational neurons. The fibers from these neurons always grow into the sensorimotor field of action, becoming consolidated with the primary structural counterpart of the form of the behavior pattern.

"It is possible also that conditioning processes are registered in structural counterparts in the sense that neural mechanisms acquire functional specificity with reference to the experience. In the counterpart of the form of the pattern, the specificity of function is fixed by the relations into which the elements grow. In the counterpart of experience, on the other hand, specificity of function is established by interaction of growth and excitation; that is to say, the excitation fixes upon the growing terminals of neurones its own mode of activation. In the conditioning mechanism in general, as in the case of the Rohon-Beard cell, according to this hypothesis, laws of growth determine the structural relation of conductors, but their specific sensitivity is fixed by the mode of excitation.

"In the motor mechanism of Amblystoma we see structural counterparts of attitudes which are released into action of definite form in appropriate situations. It is possible that in the conditioning mechanisms, also, situations organize themselves into definite structural counterparts through the interaction of growth and excitation."

The Rôle of Maturation

On such an anatomical basis the processes of maturation and of learning may be brought into closer identification. It becomes more possible to resolve the antithesis of fixity and flexibility of response. The mechanisms of maturation rigidly conceived would lead to stereotypy of behavior, but not if there is an intimately associated mechanism for specific adaptations. These two mechanisms are not discrete, nor does environment operate on one to the exclusion of the other. They function together as a single mechanism which is constantly consolidated through the unifying processes of growth. And by growth we do not mean a mystical essence, but a physiological process of organization which is registered in the structural and functional unity of the total behavior pattern of the individual.

As far as the deeper principles and mechanism of growth are concerned, there can be no abysmal difference between the patterning of behavior in the Amblystoma and in the infant. Although the underlying neuro-anatomical details are now more completely known for the salamander and although the neural overgrowth of the cerebrum is vastly more complex in the human organism, the elementary developmental physiology of the constituent neurons may be assumed to be essentially alike in both species. That the basic rôle of maturation even in the spheres of learning may be fully recognized, it should be pointed out that the associative neural structures concerned with the highest forms of mental adaptation in man are brought to an advanced stage of developmental organization in the early fetal period, long before these structures serve their most refined functions of specific and orientational adaptation. Such anticipation in the histological "morphology" of the nervous system determines the primary attitudes, the intrinsic initiative of attitude, "the forward reference" of behavior of the organism emphasized by Herrick (25) as well as Coghill (8). In the very nature of things the quality and primary architecture of

this neural mechanism must be a product of inherent growth, determined by the genes. Here lies at least the foundation of individual differences in the patterning of behavior. To this extent the factors of maturation assert their sway even in the sphere of learning.

The concrete and substantial data which have accumulated through the experimental analysis of development in the lower forms furnish a solid basis for the preliminary interpretation of the rôle of maturation in the patterning of human behavior. This statement assumes that the biochemistry and mechanics of human development are in a considerable measure prefigured in the growth of lower organisms. But even if we should postulate that the physicochemical system of the human cortex has distinctive characters, it is altogether unnecessary to assume that these characters are entirely unique and incomparable with the physiological processes prevailing in the neural tissues of organisms lower in the evolutionary scale.

The rôle of maturation in the patterning of human behavior will be briefly discussed under the following rubrics: (*a*) physical constitution; (*b*) the ontogenetic sequence; (*c*) developmental correspondence in twins; (*d*) inherited behavior characteristics; (*e*) the development of sensorimotor functions; (*f*) intellectual and affective life.

Physical Constitution

The operation of maturational factors in the first structuring of the embryo has already been incidentally considered. The early period of organogenesis antedates the period when behavior patterning begins. It cannot be doubted that this organogenesis is largely controlled by maturational factors. The morphology of the organs and the order of their appearance are primarily determined by the genetic system interacting with intracellular and intercellular environmental conditions. The end-products of this early growth, both normal and atypical, project themselves as constitutional characteristics throughout the later life-cycle.

The projective perpetuation of such constitutional characteristics is well illustrated in hemihypertrophy. Hemihypertrophy is a developmental anomaly which produces a more or less complete unilateral asymmetric enlargement of the individual. Hemihypertrophy may be regarded as a minimal form of twinning which occurs as an imbalance of the normal embryonic process of bilateral cell division, bringing about disturbances of normal tissue development. As a consequence of these disturbances of tissue development, hemihypertrophy is frequently associated with mental defect. This rare anomaly is instructive because it provides a glimpse of the inner mechanisms of development and demonstrates that the internal regulation of the process of growth has, from the beginning, a powerful influence in shaping the characteristics of the individual (15).

There is no evidence that hemihypertrophy is due to a hereditary defect in the genes. It more probably rises out of an epigenetic factor in the internal environment, which slightly distorts the normally symmetrical

processes of developmental duplication. The mechanism of normal symmetry is impaired because of some inexactness in the physical environment or some partial retardation, resulting in uneven oxygen formation (48). To what extent many problems of symmetry and asymmetry, including eyedness, handedness, and other forms of unilaterality, trace back to the period of embryogenesis is not known. The condition of hemihypertrophy, however, is very significant because it shows the importance of the maintenance of balance in tissue development. Doubtless many deviations of physical constitution trace back to this embryonic period, and, because growth is consistently integrative, such constitutional differences influence the course of behavior patterning throughout life.

The Ontogenetic Sequence

Patterns of behavior in all species tend to follow an orderly genetic sequence in their emergence. This genetic sequence is itself an expression of elaborate pattern—a pattern whose basic outline is the product of evolution and is under the influence of maturational factors. The studies of Swenson (50), Avery (2), and others have shown that in the rat and in the guinea pig and other mammalian forms the behavior sequence tends to follow a time schedule. The schedule differs with species but is much alike for individuals of the same species. The studies of Minkowski (37) and others have shown the presence of a developmental sequence in behavior patterning for the human fetus. On the basis of available records, Coghill (8) is convinced that the principle of embryological development governing this early patterning of behavior in man is the same as that in Amblystoma. Shirley (46) has found uniformities of sequence in the development of human posture and locomotion.

Our own studies of premature and postmature infants have demonstrated a high degree of stability in both prenatal and postnatal ontogenesis when the end-course of development is not interfered with by traumatic and disease factors (16). The uterus is the normal environment of the fetus until the end of a gestation period of forty weeks. But birth with survival may very exceptionally occur as early as twenty-four weeks and as late as forty-eight weeks, an enormous range of variation in natal age amounting to six lunar months. Variation within a range of three lunar months is relatively common and yet this considerable variation does not impose a corresponding deviation in the complex of behavior. Our normative studies of both premature and postmature infants have shown repeatedly that the growth course of behavior tends to be obedient to the regular underlying pattern of genetic sequence, irrespective of the irregularity of the birth event. Refined studies will doubtless reveal that such irregularity does subtly modify many details of behavior but nothing points more comprehensively to the rôle of maturation than the general stability of the trend and the tempo of development in spite of precocious or postponed displacement of birth. The patterns of genetic sequence insure a basically similar growth career for full-term, pre- and post-term infants. It is as

though Nature had provided a regulatory factor of safety against the stress of extreme variations of environment. In the mechanisms of maturation this regulation operates.

Developmental Correspondence in Twins

Twins furnish a fertile field for the study of maturational factors. Fraternal twins tend to show the same kind and probably the same degree of differences as ordinary siblings. Jacob and Esau are a classical example of twins who differed in mental and physical traits. To what extent the mere fact of contemporaneous birth and career affects the parity of characteristics is not known. In the present brief discussion we shall first consider the problem of physical correspondence and divergence in monozygotic twins.

The identity of origin of such twins makes for similarity in stature and body type, and for detailed correspondence in the color, form, and structure of organs. The inequality in the conditions of development, however, may impose a more or less permanent difference in weight and vitality. Hence the frequency of the occurrence of a weaker twin, who yet extensively duplicates his co-twin.

F. Beckerhaus (3) studied twelve pairs of unioval twins who showed marked similarity as to hair, skin color, iris, cornea, and total refraction of eyes, and who exhibited an inherited disposition to the formation of freckles. Yet there were minute but detectable differences in respect to all these qualities.

Sano (45) found a very remarkable similarity in the disposition of the furrows of the cerebral hemispheres of the brains of identical twins who were stillborn at full term—this in spite of a difference in size of the brains.

Gesell and Thompson (22) have reported medical and anthropometric details showing remarkably stable correspondence in twin infants *T* and *C*, up to eighty weeks of age. Daily determinations of weight, and of temperatures for 450 days, as well as body measurements, dentition, and skin patterns were compared. At the age of nineteen weeks the twins were sent to a hospital where a diagnosis of acute intestinal intoxication was made. On the very same day, symptoms in both twins suddenly became worse. They showed marked ashen pallor, drowsiness, and symptoms of extreme dehydration. Similar treatment was administered. A total of 400 cc. saline was given immediately, subcutaneously and intraperitoneally; 75 cc. intravenous glucose was given at the same sitting; shortly after, 150 cc. of citrated blood was given by transfusion per fontanelle; the following day 300 cc. saline was given subcutaneously. On the fifteenth of November the symptoms cleared and both patients showed decided improvement. The contrast with their appearance on admission was considered little less than remarkable. The course of convalescence in both children was similar, and they were discharged as cured at the end of sixteen days.

Four days prior to discharge, however, Twin *C* showed symptoms of acute bilateral ototis media of the suppurative type. In spite of this complication, it is significant that both children made very similar weight gains during their fortnight at the hospital. Twin *T* entered with a weight of 5480 grams and left with a weight of 6080 grams—a gain of 600 grams; Twin *C* entered with a weight of 5340 grams and left with a weight of 6000 grams—a gain of 560 grams. One day they weighed exactly alike to a gram!

Such amazing identity of reaction to an infection, and to its heroic treatment, strongly suggests that the correspondence in highly similar twins inheres in the very biochemical constitution, supplying a firm matrix for the development of correspondence in psychological make-up.

The physiological basis of behavior correspondence is clearly demonstrated in a recent study by Macfarlan (34). The hearing of middle-aged twin sisters was tested by an audiometer. A marked parallelism was shown; the hearing rose and fell across the pitch range in nearly exact correspondence.

With such a wealth of correspondence demonstrated in the physical development of twins, it becomes interesting to inquire whether there is a comparable degree of behavior correspondence in twin development. This problem, of course, is more complex. There is, after all, some difference between patterns of the skin and patterns of behavior. The configuration of the friction ridges of the skin is fixed for each individual in the fourth month of intra-uterine life and, unaltered, this dermal pattern is carried to the grave.

The mental characteristics of the human organism, on the other hand, are in process of almost constant change. It is impossible to seize upon stable criteria of comparison like thumb prints. Yet there is no reason to believe that the complex of mental growth is immune from those same factors which make for correspondence in the dermal patterning of sole and palm.

Twins *T* and *C*, who showed such thoroughgoing physical correspondence as reported by Gesell and Thompson (22), were also studied from the standpoint of psychological correspondence. Periodic developmental observations were made by individual and comparative examinations throughout their infancy. Motion-picture records were utilized.

A marked degree of resemblance in behavior patterns was displayed. The correspondences in behavior patterning were literally uncountable. However, the records of 13 developmental examinations were analyzed, and 612 separate comparative ratings of behavior items were made from these records in order to determine features of correspondence and disparity. There were 99 items of minor disparity, and 513 items of identical or nearly identical correspondence. A generic and detailed parity of behavior patterns was decisively demonstrated.

In the field of pellet prehension this parity was very neatly disclosed. A small pellet, 7 millimeters in diameter, was placed on a table top before

each child, within easy reach. At twenty-eight weeks both the twins, being somewhat retarded in their development, were visually unheedful of the pellet, though they definitely regarded a cube. At thirty-eight weeks they addressed themselves in an identical manner to the pellet. The hands were placed in full pronation, the fingers were fully extended, and spread apart in a fan-like manner. The thumb was extended almost at right angles. The motion-picture record of the twins' attack upon the pellet shows an almost uncanny degree of identity in the details of postural attitude, hand attitude, approach, and mechanism of grasp. At forty weeks there was a crude raking attack upon the pellet; at forty-two weeks this raking approach was replaced by a poking with the tip of the index finger. These changes in prehensory pattern occurred contemporaneously in both children.

We turn to another example of behavior correspondence in the infant Twins *T* and *C* at the age of forty-four weeks. The twins were confronted with a test performance box with its three holes. The common method of approach of the two children, their preferred regard for the edge of the performance box, the fleeting regard for the holes, the exploitation of the vertical surface of the performance box by a scratching, simultaneous flexion of the digits, the failure to place a round rod into any of the holes, the brushing of the surface of the performance box with the rod, the transfer of the rod from one hand to the other, and, finally, an almost simultaneous, peculiar, clicking vocalization in both twins—altogether constituted a very complicated behavior patterning, but one which bristled with numerous identities of spatial and dynamic detail. One can give due weight to the significance of this correspondence only by reflecting on the myriad of behavior exploitations of the situation which the twins *might* have adopted. But, in spite of this multitude of exploitational possibilities, the twins were apparently under a common inner compulsion to adopt those very similarities of behavior which have been noted.

The complex nature of these behavior correspondences again suggests the fundamental rôle of maturation. If it were argued that extrinsic factors determine the form and the occasion of such simultaneous patterns, it would become necessary to demonstrate in detail a cunning arrangement of environment and of conditioning stimuli competent to design in duplicate the configurations of the observed behavior. How can the environment, even of twins, accomplish such architectonic miracles? (18).

Ley (33) has published an excellent monograph on *Un cas d'audimutité idiopathique (aphasie congénitale) chez des jumeaux monozygotiques.* The subjects, two boys, A and J, age eight years, present a remarkably synchronous developmental career with retardation in walking and in speech. They both had "convulsions" up to two years of age, J more frequently than A. Dentition and walking occurred late, the former at two years, the latter at three and one-half years. At four, both had a light bronchitis; at five, night fears. Each pronounced his first words at four. They were both so destructive that at five the parents were

obliged to place them in an institution for abnormal children. At eight, they appeared normal at first sight, but upon examination were found to express themselves with the greatest difficulty, to fall easily in walking or running, and to be unable to understand the damage they caused. They utilized the gesture language effectively with each other but did not attempt to communicate with a third person. The indications of normal reactions were excellent memories and good attention (but solely for things which interested them). Unlike aphasics, they were not timid. Physical examination results showed no sign of lesion. Asymmetry reversal was present in hair whorls, finger prints, and skull form. In play, A preferred the left hand, J the right. Upon intelligence examination, A and J passed tests which placed them at the eight-year level except for drawing and number concept. In résumé the author characterizes them as follows: They were incontestably "monozygotic," with great asymmetry reversal, and an analogy of bodily and mental development which approached absolute identity. Minute medical and neurological examination was completely negative. The essential difficulty was in the motor sphere—in spite of normal development and perfect peripheral stimulation of all their organs, they could not make certain voluntary movements. They not only learned to walk late but had difficulty with complicated movements; could not correctly articulate words; could not draw or imitate difficult gestures. They understood the significance of drawings and gestures. Their motor difficulty consisted in a considerable retardation of development of the *"praxique"* functions. Great parallelism existed in the development of their intelligence, in which there were essential gaps, particularly in abstract concepts.

Inherited Behavior Characteristics

We need not undertake any critical discussion of the complicated problem of the inheritance of mental traits. It is evident that the inborn traits of an individual can be brought into realization only through the processes of maturation. However much these traits may be specifically modified and inflected by environment, their initial manifestation will be primarily determined by maturation. That the maturational mechanism may operate with morphological precision even in the field of behavior is suggested by some of the results of Stockard's highly important experimental work in the breeding of dogs (48).

He has experimentally investigated problems of experimental morphology by the hybridization and interbreeding of pedigreed dogs. He has been chiefly concerned with the genetics and endocrinology of the somatic constitution of his dogs but his work throws striking side-lights on the developmental basis of behavior patterns. He finds in his hybrid litters assortments of temperamental and instinctive traits which indicate a well-defined hereditary determination. He finds that the general complexion of behavior in hybrid offspring tends to correlate with the shape of the cranium more than with body build.

He has bred an interesting cross between the Saluki hound and the Basset hound. The Saluki is a tall, slender, aristocratic creature who has come down through the ages (thanks to the stable genes) with a physical (and probably a psychological) pattern quite similar to that of the domesticated dog portrayed by the ancient Egyptians. The Basset hound is low-flung, stocky, and short legged. Saluki, on assuming a prone position, puts out his long forelegs with a graceful extensor thrust. Basset, when he settles down, folds his short forelegs inwards with a flexor movement. And what do the strange-looking, short-legged, hybrid puppies do when they take a prone posture? In spite of the anatomical grotesqueness of it, they extend their short legs as though they belonged to the ancestral Pharaoh strain. In other words, the musculature of the Basset-like extremities is controlled by the neuron mechanism of a Saluki type. This is evidence that a specific behavior pattern may be transmitted as an entity in spite of crossbreeding, the pattern preserving its integrity even under the influence of an incongruent anatomical structure derived from an alien strain. Here maturation works with a vengeance.

It is probable that in man also there are innumerable behavior characters which rest upon relatively specific pattern determiners within the individual constitution. Such inherited patterns and pattern trends as well as more generalized potencies can come to expression only through a process of maturation. Although adaptive to and responsive to environment, they are in no sense derived from the external environment.

Sensorimotor Functions

In the developmental patterning of such fundamental functions as posture, locomotion, eye-movements, and prehension the factors of maturation work with considerable force—in the human infant as well as in the lower animals. As already indicated, the ontogenetic sequence for such functions, though differing for species, tends to remain consistent within the species. There are many purely individual differences, but many of these seem to arise out of variations in the original growth equipment rather than in the physical environment.

Coghill (9) doubts whether the appearance of a function like locomotion can be hastened in Amblystoma by exercise. Carmichael (6) found that swimming movements appeared at the appropriate time in Amblystoma embryos even when these embryos were completely deprived of external stimulation by an anaesthetizing solution of chloretone. Bird (4) hatched large numbers of chicks and kept them in darkness for varying periods of time. This was equivalent to specific anaesthetization of the behavior pattern of pecking, for chicks do not peck in the dark. There proved to be only a small difference in pecking performance between practiced chicks and those reared in the dark; and even this small difference may have been due to differences in vitality.

In the human fetus there is a comparable certainty in the progressions of sensorimotor functions, with slight dependence upon exercise and stimu-

lation. The lawfulness of such progression is most clearly revealed in the development of visual-manual behavior and may be briefly illustrated by the findings of our normative studies of pellet prehension (21).

The following normative synopsis covers twelve lunar-month periods beginning at eight weeks:

8 weeks: no visual regard for pellet
12 weeks: transient regard for pellet (rarely)
16 weeks: more prolonged regard, usually delayed
20 weeks: immediate, definite regard, sometimes with increased hand-arm activity
24 weeks: approaches pellet with pronate hand; contacts pellet with little or no finger adjustment
28 weeks: approaches pellet with raking flexion of fingers, without thumb opposition; occasional delayed palmar prehension
32 weeks: approaches pellet with raking flexion but with increased thumb participation and digital prehension
36 weeks: approaches and contacts with simultaneous flexion of fingers: prehends with defined thumb and index opposition
40 weeks: approaches with all fingers extended; contacts with index finger and later prehends by drawing index finger against thumb
44 weeks: promptly prehends with index and thumb and with increased obliquity of hand attitude
48 weeks: approaches with index finger extended and lateral digits flexed; prehends with delimited plucking by index and thumb
52 weeks: approaches and plucks pincerwise with increased deftness

If the foregoing table is studied in perspective it shows that the development of eye-hand behavior in the infant does not consist so much in an increase of skill as in a progressive differentiation of the mechanical form of behavior. To be sure, there is a trend toward economy of movement; but this is not an end-result of practice but an alteration in the very pattern of response. The developmental reorganization of this pattern is outwardly a morphological phenomenon primarily correlated with changes in the inner morphology of the nervous system, and secondarily with changes in ligaments, joints, and musculature. Howsoever environment may inflect and condition the expression of the visual-motor functions, the mechanics of the behavior and the basic form of the patterns are primarily the product of maturational factors.

Ocular movements and prehension constitute a favorable field for the objective study of the temporal-spatial forms of behavior by methods of cinema analysis used by Halverson (23), McGinnis (35), and Castner (7). The indubitable presence of morphogenetic factors at the basis of these behavior forms suggests that similar factors may operate in the more concealed ontogeny of the higher thought processes. These processes have an ontogeny as well as a dynamics.

Intellectual and Affective Life

The rôle of maturation in the higher spheres of intellectual and moral life is, on the basis of present knowledge, difficult to determine. On theo-

retical grounds some may even question whether the concept of maturation can be applied to these higher and more rarefied fields of behavior accessible to introspection but not to photography. Nevertheless, if there is a general physiology of growth which governs the entire development of the individual, we may well believe that maturation maintains a rôle in the higher orders of thought and feeling.

Neurons grow. Laboratory investigation has shown that electropotentials are moving factors in that growth. Axons grow away from a cathode pole (Bok's law); dendrites grow towards an active neuron or nerve bundle and cathode pole (Kappers' law). The cell-body may also migrate in the same direction as its growing dendrites. Coghill (10) has emphasized the fact that neurons continue to send out (and organize) processes even after they have begun to function as conductors, and has even suggested that the creative component of thought is a form of growth. Kappers has remarked that his law of neurobiotaxis resembles the psychological law of association. E. B. Holt (27) believes "that with a very small additional consideration as to the direction in which the excitations flow, it *is* the psychological law of association."

Accordingly it is possible to posit a maturational kind of mechanism even in the spheres of symbolic thinking represented by language, thought, and moral attitudes. Granting that these spheres are elaborately influenced by social and environmental factors, they nevertheless require a substratum of maturation similar to that which underlies the simpler sensorimotor functions like prehension.

Strayer (49) reports some valuable findings in this direction based on a study of language development in identical twins by the method of co-twin control. Both twins were given a similar course of vocabulary training in the early stage of language formation, but Twin *T* was trained five weeks earlier than Twin *C*. The maturity difference of five weeks showed itself clearly in the language behavior of Twin *C;* she responded more effectively to training and her pattern of response was more mature. There was a more rapid elimination of doubling of syllables (like *ba-ba* for ball). This was a sensorimotor advantage, but there was also an intelligence advantage (and this is of especial significance in the present connection). Twin *C* showed less interference of associations; "she incorporated the new words more quickly into her spontaneous jargon and extended her applications earlier and more widely, using them more often." These latter functions are modalities of behavior, akin to those which operate on higher levels of generalization and of reasoning. Such modalities can in no sense be explained on the basis of habit formation or of environmental moulding, however dependent they are on social stimulation. Rather, they arise out of maturational factors which are relatively independent of specific training. We may regard Strayer's study as a virtually experimental demonstration of the existence of such maturational factors in intellectual functions.

Although generic modalities of behavior do not have a morphological

configuration in the same precise sense that a method of prehension has a visible design, there is no reason why these modalities should not be represented in the nervous system by innate developmental factors which serve to incorporate the influences of the social environment. This process of incorporation is a form of growth, closely articulated with the total action system. Even thinking, or at least the creative component of thinking, as already suggested, is a growth phenomenon.

Piaget (40-43) has made extensive psychological studies of the child's language, early forms of reasoning, articulate concepts of physical causality and of cosmology, and the nature of moral judgment. His approach upon the problems is at once philosophical, clinical, and genetic, and in his last work (44) he has made correlations with the literature of theoretical sociology. In his interpretations he uses biological concepts only to a limited extent and it therefore becomes interesting to inquire into his views concerning the interaction of the individual and environment. We quote a few passages which in spite of a certain abstruseness indicate the lines of his interpretation:

> "This concordance of our results with those of historico-critical or logico-sociological analysis brings us to a second point: the parallelism existing between moral and intellectual development. Everyone is aware of the kinship between logical and ethical norms. Logic is the morality of thought just as morality is the logic of action. . . . One may say, to begin with, that in a certain sense neither logical nor moral norms are innate in the individual mind. We can find, no doubt, even before language, all the elements of rationality and morality. Thus sensori-motor intelligence gives rise to operations of assimilation and construction, in which it is not hard to see the functional equivalent of the logic of classes and of relations. . . . The control characteristics of sensori-motor intelligence is of external origin: it is things themselves that constrain the organism to select which steps it will take; the initial intellectual activity does actively seek for truth. Similarly, it is persons external to him who canalize the child's elementary feelings, those feelings do not tend to regulate themselves from within.
>
> "This does not mean that everything in the *a priori* view is to be rejected. Of course the *a priori* never manifests itself in the form of ready-made innate mechanism. The *a priori* is the obligatory element, and the necessary connections only impose themselves little by little, as evolution proceeds. It is at the end of knowledge and not in its beginnings that the mind becomes conscious of the laws immanent to it. Yet to speak of directed evolution and asymptotic advance towards a necessary ideal is to recognize the existence of a something which acts from the first in the direction of this evolution. But under what form does this 'something' present itself? Under the form of a structure that straightway organizes the contents of consciousness, or under the form of a functional law of equilibrium, unconscious as yet because the mind has not yet achieved this equilibrium, and to be manifested only in and through the multitudinous structures that are

to appear later? There seems to us to be no doubt about the answer. There is in the very functioning of sensori-motor operations a search for coherence and organization. Alongside, therefore, of the coherence that characterizes the successive steps taken by elementary intelligence we must admit the existence of an ideal equilibrium, indefinable as structure but implied in its functioning that is at work. Such is the *a priori*: it is neither a principle from which concrete actions can be deduced nor a structure of which the mind can become conscious as such, but it is a sum-total of functional relations implying the distinction between the existing states of disequilibrium and an ideal equilibrium yet to be realized."

The foregoing interpretation, although too mentalistic to be readily brought into a biological discussion, indicates the presence of *"a priori"* factors which may be envisaged in terms of maturation. These factors become somewhat less mystical if they are ascribed to the growth characteristics of a total action system whose elementary mechanisms have been studied by direct approach. However potent and pervasive social environment may be, basic organization of the higher thought processes is probably determined by primary ordering factors within the growing organismic pattern.

Likewise with the affective life of the infant. The primary emotions have been discussed as though they were elementary stable phenomena subject only to the changes of social conditioning. This is the implication in much that has been written concerning the emotion of fear. It seems to us that the problem has been oversimplified. Fear may be an original tendency, but it is possibly subject to the genetic alterations of maturation as well as to organization by environmental conditioning. Such conditioning may determine the orientation and reference of fears, but the mode of fearing may well undergo change as a result of maturation. Fear is neither more nor less of an abstraction than prehension. It is not a simple entity. It waxes and alters with maturity. It is shaped by intrinsic maturation as well as by experience, certainly during the period of infancy.

A discussion of the developmental aspect of intellectual and affective life should make at least brief mention of the phenomenon of invention and mental creativeness. Does maturation play a rôle here too? What is known about the biological process of mutation and of human variability suggests that a mechanism of maturation is requisite for manifestations of originality. Such manifestations cannot be derived from the environment alone, either in children or adults. Even originative and mutational expressions of individuality emerge out of a complex of growth. Similarly, the more marked differences among adults with respect to the prolongation of intellectual plasticity must have their basis in the constitutional growth potential.

Maturation and Training

There has been an increasing number of studies dealing with the effects of training on the acquisition of skill in children. The influence of age

and of practice distribution on the improvement of abilities raises many questions concerning maturation factors. The contributions and bibliographies of Gates (14), Jersild (32), Hilgard (26), and Wheeler (51) may be especially mentioned.

In identical twins nature provides a stage for observing the effects of a developmental stimulus which may be experimentally confined to one twin. We have described elsewhere (22) the method of co-twin control which was first used to analyze the influence of training in relation to maturity. Having established the presence of a thoroughgoing similarity of a pair of infant girl twins, one twin (Twin *C*) was utilized as a duplicate control. Twin *T* was subjected to a program of daily training in climbing and in cube behavior for a period of six weeks, beginning at the age of forty-six weeks. Twin *C* (reserved as a control) was deprived of all specific training in these reactions. At the age of fifty-three weeks Twin *C* was subjected to a brief period of training in climbing, lasting two weeks. The purpose of this deferred training was to check and to extend the analysis of the interdependence of maturity factors and training factors. Twin *T*'s early reactions to training were relatively passive, and she needed assistance at one or all of the five treads. After four weeks of training (age fifty weeks) she climbed the staircase with avidity and without assistance. At fifty-two weeks she climbed the staircase in 26 seconds. Twin *C*, at the age of fifty-three weeks, without any previous training, climbed the same staircase unaided in 45 seconds. After two weeks of training, at the age of fifty-five weeks, Twin *C* climbed the stairs in 10 seconds. The climbing performance of Twin *C* at fifty-five weeks was far superior to the climbing performance of Twin *T* at fifty-two weeks, even though Twin *T* had been trained seven weeks earlier and three times longer. The maturity advantage of three weeks of age must account for this superiority.

Twin *T* was trained daily in cube behavior from forty-six to fifty-two weeks of age. A day-by-day analysis of this cube behavior showed a trend toward daily changes and increments in prehension, manipulation, and exploitation. At the close of the training period, however, the cube behavior patterns of Twin *C* were highly similar to those of Twin *T*. It is suggested that the growth complex, being under the stress of continuous (diurnal) maturational changes, cannot assimilate in any permanent way the effects of ordinary training or casual suggestion. The similarity in patterns of cube behavior was confirmed by a time-space cinema analysis of the prehensory reactions to cubes under experimental conditions at forty-two, fifty-two, sixty-three, and seventy-nine weeks of age.

The method of co-twin control has also been used by Strayer (49) to analyze the relationship of language and growth and to determine the relative efficacy of early and deferred vocabulary training. Very favorable arrangements for the temporary separation of the twins and for continuous twenty-four–hour observation were made. Twin *T*'s training was begun when she was eighty-four weeks old and continued through her eighty-

eighth week. Twin *C*'s training was begun when she was eighty-nine weeks old. Careful records of all word use and language behavior were kept; and these were later compared in quantitative detail.

The findings of the experiment indicated that the typical stages in "the acquisition of language were strikingly alike for both twins, but in practically every phase Twin *C* was slightly in advance of Twin *T*." This was attributed to the age difference of the twins during the identical (but not contemporaneous) training programs. Not only was the training which was begun with a maturity advantage of five weeks more effective than earlier training, but the patterns of response of Twin *C* were more mature. Strayer offers abundant detail concerning the comparative career of individual words learned by *T* and *C*, which illuminates the conditions of learning. Training does not transcend maturation.

The Relationship of Maturation and Learning

The foregoing summary of various evidences of maturation leads us back to a brief consideration of the relationship of maturation and learning. This is, of course, a difficult problem and would demand a critical analysis of the numerous factors which operate in so-called learning: practice, forgetting, refractory-phase phenomena, conditioning (inhibitory and remote), repetition, emotional reinforcement, etc. An estimate of these factors would inevitably prove the difficulty, if not artificiality, of drawing a distinction between dynamic and developmental processes. Where, indeed, shall the line be drawn in the border zone between dynamic psychology and developmental psychology? Would not dynamic processes which take place in a short period of time assume a developmental aspect if drawn out durationally after the manner of the slowed cinema projection? And, conversely, would not developmental phenomena simulate dynamic, if telescoped into a small span of duration?

The newer formulations of learning reflect this point of view. D. K. Adams (1) characterizes learning as "the process of reorganization sometimes undergone by fields distorted by an obstructed need," and suggests that "when in such fields learning does not occur, the other sort of adaptation (change in the need) must occur." Similarly, Humphrey (28): "As biological evolution progressed, organic complexes were able to respond more and more intimately to changes in the environment, until there was developed the power to make a dynamic adjustment to a highly complex four-dimensional manifold. This is the power to learn." E. B. Holt (27), in his effort to merge genetic and dynamic aspects, uses the remarkable phrase "developmental growth or learning." "Sheer growth" (whatever sheer growth may mean) is a term which has sometimes been used in contrast with "environmental moulding."

Analytically it is possible, and scientifically it is desirable, to draw a distinction between maturation and learning. The end-products are blended beyond dissection; the mechanisms are alike in principle; they operate synthetically in determining the ultimate patterns of behavior; but

they are not identical. Carmichael (6) suggests that "in all maturation there is learning and in all learning there is hereditary maturation." But it does not follow that they are one and the same thing; unless we grant that there are forms of maturation which are so precisely adaptive that learning is ruled out. Significantly enough, we cannot conversely suppose that learning ever takes place without a maturational component. Marquis (35), in his excellent discussion of the criterion of innate behavior, suggests that there is a fundamental distinction to be made as follows:

> "Learning represents a modification of the organismic pattern in response to specific stimuli present in the external environment at the time of the modification. Maturation, on the other hand, is a modification of the organismic pattern in response to stimuli present in the intracellular and intercellular environments, which at the given moment are independent of external influences."

This distinction is a defensible one, but it is unnecessary to make it hang too exclusively on immediately present stimuli. Recent stimuli also operate, and emphasis should be placed on the specific nature of the adaptation to both present and recent stimuli. If the term *recent* introduces difficulties of interpretation, these are of a constructive character and reflect the close bonds between maturation and learning, without obscuring the difference between external and internal environments.

The intimate relationships between maturation and learning were neatly disclosed in a simultaneous comparative observation (18) of identical twins, if we may again refer to *T* and *C*. A fundamental identity in behavior responses was shown in the pellet-and-bottle situation. The twins were in the same crib, seated back to back, and confronting each her own examining table. The two examiners simultaneously held a small 4-ounce glass bottle in view and dropped a 7-millimeter pellet into the bottle. Three trials were made with each child. The examiner, having dropped the pellet into the bottle, gave the bottle to the child.

Both children watched this dropping of the pellet with the same transfixed attention. Both children on the first trial, and again on the second trial, seized the bottle, apparently heedless of the contained pellet; but both children on the third trial (without, of course, any influence of imitation) pursued the pellet by poking at it against the glass—identical capacity to profit by experience.

In this instance we find that the correspondence of behavior patternings extends into the minute fields of specific adaptation or of learning. It may be readily granted that maturational factors primarily account for the similarity in capacity and general maturity displayed by these twins. Perhaps these same maturational factors account also for the more detailed correspondences, such as the mode of visual attention, the primary preoccupation with the bottle, and the secondary interest in the pellet. Within a brief span of time we see the spontaneous behavior patterns undergo a specific adaptation and call this adaptation learning. But the distinctive criteria of maturation and learning are not easily applied.

Let us assume that on the morrow, in the pellet-and-bottle situation, both children poke immediately with extended forefinger against the side of the bottle. Is this fixation of behavior due to the experience of the previous day? And shall the assimilative processes of the intervening night be regarded as maturation because the modification did not occur in immediate response to the situation, or shall it be called learning because it is virtually a specific adaptation to stimuli recently in the external environment? The fixation of the poking pattern, however, proves to be temporary, because in another lunar month without specific experience these same twins adaptively tilt both bottle and hand, and thrust the extended index finger into the open mouth of the bottle in pursuit of the pellet. Is this incremental differentiation of behavior pattern to be attributed to maturation or to learning?

Maturation and Growth Regulation

We may look upon maturation as part of a general process of developmental regulation as well as a morphogenetic process which works toward more or less specific end-results. The total complex of growth, as it were, is always meeting problems in the obstructions, stresses, and deficiencies, both of internal and external environment. The maximum developmental success of the organism is rarely achieved, but in all growing organisms there is apparently a tendency toward a maximum. We may postulate this as a developmental principle and formulate it briefly as follows: *Growth tends toward an optimum realization.*

This principle has psychological applications but it can be most concretely illustrated by examples from experimental biology. The results of the surgical alterations of a growing organism stimulate a marked tendency on the part of the structures to adapt themselves to mutilations and dislocations. For example, Detwiler (11) found that when the limb of Amblystoma was removed and grafted well behind its normal position, the nerve supply nevertheless organized itself in such a way as to establish appropriate function in the limb.

Speidel's study (47) of growing nerve cells showed a growth cone at the end of the fiber. The cone advances by a slow, irregular, flowing motion, spinning a fiber behind it. A slight temporary obstruction may cause a small thickening. A more formidable obstruction may lead to giant cones or to the formation of branches.

Boeke (5, 30) has traced the regeneration of motor end-plates. He found two stages: first, the outgrowing fiber puts out exuberant, bizarre end ramifications; in the second stage, these forms disappear and a normal form is restored. Boeke remarks:

> "And I can imagine no other process which affords such a striking example of the elements of the different tissues as subordinate parts of the whole, to reach a given end, the restoration of the equilibrium of the organism, than this mode of regeneration of the motor nerve endings."

This whole phenomenon of regeneration gives a clue to the more intricate processes of compensatory growth and of adjustment to handicaps whereby the organism "seeks" a maximum in the sphere of behavior. Nerve tissue itself has very limited capacity for regeneration, but the nervous system as a whole plays the dominating rôle in preserving the integrity of the organism in the face of such handicaps as malnutrition, loss of sense-organs, and loss of motor capacity. The total reaction system of the individual tends to be ordered and coherent even though its resources and instrumentalities are imperfect. In many instances serious handicaps seem to be much less disastrous than one might suppose. Even grave degrees of malnutrition, correlated with excessive subnormality of weight, are usually incompetent to inflict any drastic changes upon the forms of fundamental behavior patterns and upon the genetic order of their sequence. While it is granted that certain food deficiencies, for example, in the field of calcium metabolism, definitely influence the general picture of behavior, the nervous system itself is remarkably resistant to general adversity, even to partial starvation. When certain areas of the nervous system are actually damaged by disease or injury, maturation cannot make amends, but the maturation of the nervous system seems to proceed toward the optimum in the areas unimpaired, even though lacking the stimulus of exercise of the functions controlled by the impaired areas. It is for this reason that certain clinical types of profound motor disability attain none the less considerable approximation to normality in certain patterns of behavior.

We have described elsewhere (18) the marked degree of patterned mental growth which may take place in a child suffering from severe birth injury. This child at the age of five years could not sit, stand, talk, or grasp, but had attained in several fields of behavior a significant approximation toward normality.

If the sources of energy on which growth depends are not stopped, as they completely are in profound idiocy, then there remains a measure of specific and general potency. This potency expresses itself in the progressive maturation of modalities and dispositions of behavior, even when normal patterns of behavior cannot be consummated. Herein lies the urgency, the almost irrepressible quality, of growth. Herein lies a life-tendency which works toward adjustment, harmony, and completion even in the gravely handicapped child. Accordingly there is an optimum utilization of impaired instrumentalities and impaired impressions. This tendency toward optimum development is in the individual comparable to the recognized, though poorly understood, evolutionary trend of the racial stream of life (16).

* * * * *

The extreme versions of environmentalist and conditioning theories suffer because they explain too much. They suggest that the individual is fabricated out of the conditioning patterns. They do not give due

recognition to the inner checks which set metes and bounds to the area of conditioning and which happily prevent abnormal and grotesque consequences which the theories themselves would make too easily possible. Although it is artificial to press unduly a distinction between intrinsic and extrinsic factors, it must, after all, be granted that growth is a function of the organism rather than of the environment as such. The environment furnishes the foil and the milieu for the manifestations of development, but these manifestations come from inner compulsion and are primarily organized by inherent inner mechanics and by an intrinsic physiology of development. The very plasticity of growth requires that there be limiting and regulatory mechanisms. Growth is a process so intricate and so sensitive that there must be powerful stabilizing factors, intrinsic rather than extrinsic, which preserve the balance of the total pattern and the direction of the growth trend. Maturation is, in a sense, a name for this regulatory mechanism. Just because we do not grant complete dichotomy of internal and external factors, it is necessary to explain what keeps the almost infinite fortuities of physical and social environment from dominating the organism of the developing individual.

The organismal concept requires that the individual shall maintain an optimum or normal integrity. The phenomena of maturation suggest the stabilizing and inexpugnable factors which safeguard the basic patterns of growth. Just as the respiration of the organism depends upon the maintenance of constant hydrogen-ion concentration, so, probably on a vastly more intricate scale, the life-career of the individual is maintained by the physiological process of growth in which the maturational mechanisms play an important rôle. The rôle is most conspicuous in infancy, but it persists throughout the life-cycle until the growth potential completely subsides.

Growth is governed by laws which will yield to scientific formulation. Scientific determinism does not spell fore-ordination; but aims to bring even "freedom" within the limits of law and therefore also within the limits of comprehension. An absolutely whimsical and fortuitous freedom would be as offensive to understanding as a stereotyped predestination. In organic evolution and in the growth of the individual these divergent extremes are kept in progressive check and balance. Viewed from one aspect, the phenomena of growth are impressive for their conservative stability; viewed from another aspect, they are impressive for their productive fertility. Plasticity is neither a negative nor a passive character. It is a positive "function of growth," a method of transconstruction or assimilation.

The concept of heredity in its classic simplicity is contradicted by the existence of this kind of plasticity. Apparently there is a process of competition and selection in the formative complex of growth. Even native endowment comes not as an inevitable bequest, but is built up through the sifting influence of competition among variable components. Some of these survive, others give way. The native endowment is thus built up through

the selective stresses of growth, and is a product of growth as well as of inheritance. Not all potentialities are realized, but only those which pass the mesh of already attained organization. All growth is self-limited. Growth is mainly determined by previous growth. But this is a progressive kind of determinism which in the field of behavior, at least, comes under human control, and is inconsistent with a fatalistic view of infancy.

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CHAPTER 5

LOCOMOTOR AND VISUAL-MANUAL FUNCTIONS IN THE FIRST TWO YEARS

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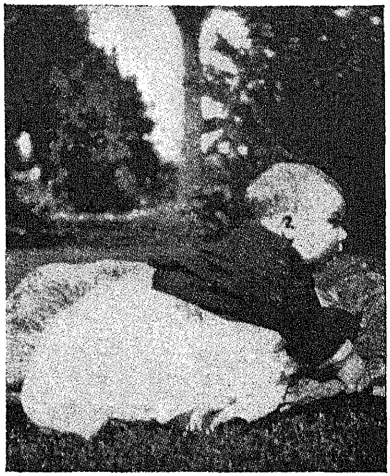
If a Hollywood director should be sufficiently impressed with the dramatic possibilities of our recent discoveries in infant development to use them as background for a modern film romance he would cast his first few sets in the laboratories of child and animal behavior. The first scene—an elaborate duplication of the Yale Clinic, perhaps—would show a ten-months-old creeper patiently toiling up a flight of experimental stairs, her every movement being scrutinized by a corps of doctors, nurses, and stenographers. Meanwhile her duplicate twin sister would be seen scuttling about in a perfectly appointed nursery, unmolested by scientific observers. The next little hero, a baby boy, would be seen at play with his blocks in a huge photographic dome; the permanently recording eyes of a cinema camera would spy upon his play. The scene would shift to such laboratories as those of Ohio State and Iowa; a white-gowned student would slide a squirming bundle onto the stage of a stabilimeter, close the window, set half a dozen pens to writing on a huge roll of paper, and seat herself before a peek-hole to watch the infant wiggle. Other sets would show patient researchers flicking the lips of a fetal kitten with a camel's-hair brush; tiptoeing into a dark room and flashing a light that would send a score of timid tadpoles scampering to the shadowed side of the pan; bending over a microscope to count the nerve cells of brain and cord.

Then a rapid "flash-back" would show a physiological laboratory in Jena in the late 1870's. A young man stoops over his cluttered table holding an egg before a candle flame. Carefully he observes and makes notes on the movements of the unhatched chick. Experimentally he watches the squirming of an embryo frog; he delivers the young of a guinea pig into a bowl of salt-water and takes notes on the feeble motions of the young fetus. He improvises an incubator for a prematurely born rabbit, that he may study its activity. After he has painstakingly recorded his observation, and has pulled a half-dozen volumes from his shelves and consulted them, the young German scientist closes his notebooks, and leaves his laboratory. But not his scientific work.

We next see him, a devoted father, but still a scientist, open the door of the nursery in his home. Softly he steals to the cradle and gently touches the eyelid of his infant son; the baby's plump fist screws itself into the offended eye, and his father, with a pleased chuckle, drags forth

7th month.—The photograph shows that traces of the early grasping with both hands, the fingers vaguely spread until the object was touched, were still to be seen.



7th month.—One of the earliest stages in the development of creeping, the mere habit of various positions propped up on the hands and knees, is well shown here.

9th month.—Standing with the slight support of the door-corner.

One year old.—The ease and freedom of this position in standing (a spontaneous one, frequently taken at the time), will give some idea of the development in security of balance.

FIGURE 1

(From M. W. Shinn's *Notes on the Development of a Child: Parts 3 and 4*. *Univ. Calif. Stud.*, 1899, **1**, Nos. 3-4, frontispiece. By permission of the publishers. The University of California Press, Berkeley, California.)

a notebook from his bulging pocket and jots down a note in German script. The scenes flit rapidly by; the baby sits alone, he creeps, raises himself to his feet, and his father fashions a long, low, cushioned bench at which the child may stand and play. Later the father is shown leading his fifteen-months-old toddler with the slender support of a lead pencil; quite suddenly the little fellow breaks away and runs around a large table. Finally the German scholar sits down at his burdened desk, examines other documents and writings on child and animal development, systematizes and assembles his voluminous notes on his son's first three years, and writes the first long and systematic treatise on infant development (91).

Thus a clever movie director might inform an audience that the foundations for the studies of motor development in the third decade of the twentieth century were laid by Wilhelm Preyer in his crudely equipped laboratory in Jena. It was he who first recognized and formulated many of the problems on which present students of child development have lavished their time and money and the resources of their well-equipped laboratories.

Preyer was not a psychologist, but a physiologist, whose interest in infant behavior grew out of his scientific researches on the physiology of the embryo. His notes on the movements of human and animal fetuses forecast the work of Minkowski (81), Bolaffio and Artom (14), Avery (6), Coronios (30), and Kao (66). He, like Coghill (26), Tilney (117), Langworthy (69), and Windle (138), was interested in the neurological basis of early movements. His characterization of *impulsive movements* as those "caused without previous peripheral excitement exclusively by the nutritive and other organic processes" anticipated the findings of Szymanski (113), Wada (127), and Irwin (60) on the activity of human infants.

Preyer clearly recognized that a large part of the baby's progress in motor control was attributable to "mental ripening" or maturation—a fact that was overlooked or minimized by Watson (131) and his students in their systematic observations of infant behavior, and that has been introduced again into the body of knowledge about infant development through the theoretical writings and the experimental work of Gesell (48), Gesell and Thompson (50), and Shirley (102).

That the order of development in babyhood was a problem worth study for its own sake and apart from the factor of age he stated in his introduction as follows:

> "No doubt the development of one child is rapid and that of another is slow; very great individual differences appear in children of the same parents even, but the differences are much more of time and degree than of the order in which the steps are taken, and these steps are the same in all individuals; that is the important matter. Desirable as it is to collect statistics concerning the mental development

of *many* infants. . . . Yet the accurate, daily repeated observations of *one* child . . . seemed at least quite as much to be desired."

Preyer was, of course, cognizant of the marked variations in the rate of development from child to child, and consequently he attached little significance to the ages at which his son performed each new motor act, although he made frequent comparisons with the ages reported by other parents. The publication of his book, *Die Seele das Kind*, in 1881, naturally gave an impetus to biographical studies of young children. Soon he was almost swamped with letters and documents from other observers and with inquiries concerning the keeping of diaries. In response to these he made outlines for the systematic observation of children during the first year (67); these outlines may be considered the forerunners of mental tests for the period of babyhood.

Hence, without slighting any of the problems of motor development in babies, or neglecting any of the recent contributions to the solutions of these problems, we may base our outline for this paper on the work of Preyer. Like him, let us first seek the origin of motor behavior in what he calls "impulsive movements" and present-day investigators term the "spontaneous activity" of the fetus and newborn. Next, let us catalog, as he did, the "reflex movements" with which the newborn infant is equipped. Thirdly, from an examination of his biographical account and from those of the many parents and research workers who have followed his example, let us trace the orderly sequence of events in the baby's development of muscular control. Fourthly, following his example, let us consider the motor development of young animals for any light it may throw upon that in the human child. Logically, this will lead us, as it did him, to an evaluation of the evidence concerning the rôle of maturation in motor behavior. Preyer called it "instinct" but he meant essentially what we mean by maturation. We shall have considerably more data than he on which to base our discussion of individual differences in the speed of motor development, and the factors that increase or decrease this speed. Finally, a review of the tests for motor skills that have been proposed by him and others and a consideration of the meager data on the relationship between motor and mental development will help us in deciding about the feasibility of using motor items in mental-test batteries.

Spontaneous Activity in the Fetus and Newborn

Methods of Study. To watch the wiggling and twisting of embryonic frogs and fish that live and develop in a pan of tap-water, as Coghill and Carmichael have done, is a relatively simple matter. But to observe the early movements of the mammalian fetus, so carefully tucked away in its bag of amniotic fluid inside the mother's body, is very difficult. The simplest method for studying fetal movements is that of delivering the fetus before term into a warm saline solution, leaving the placental circulation intact. The fetus can then be stimulated and its movements observed directly. For obvious reasons this method is largely confined to

animal experimentation. Minkowski and Bolaffio and Artom, however, have successfully applied it to spontaneously aborted human fetuses.

Szymanski devised a tambour-mounted cage or crib for studying spontaneous movements in all types of animals from the cockroach to man. His method was adopted by C. P. Richter for use in his work on the hunger drive to activity in rats. Wada also used such cribs in her study of babies. Utilizing the same principle, H. M. Johnson rigged up activity-recording beds to study the sleep of adults and children. The most elaborate and accurate pieces of apparatus of this type are the activity cabinets perfected by Weiss and his students, Pratt and Irwin, for measuring the activity of the newborn. The stabilimeter in this cabinet is capable of recording the movements of the anterior portion of the body separately from those of the posterior region.

Stimulus or Drive to Activity. Experimenters agree that most of the activity of the fetus and the newborn is aroused by internal stimuli. Concerning the "impulsive movements," Preyer writes:

> "These may be distinguished from all other movements by this, that they are caused without previous peripheral excitement, exclusively by the nutritive and other organic processes that go on in the motor centers of lowest rank."

But he adds that fetal activity can be produced or augmented by continued gentle stroking.

Szymanski (113) attributes activity in all animals to some internal timing mechanism of the bodily processes. He is concerned with the alternating rhythms of activity and rest, and he classifies animals into two types: the monophasic, which have only one prolonged period of activity and one of rest in the twenty-four hours; and the polyphasic, which have numerous periods of activity and rest in a single day. The human adult, be it remarked, along with the cockroach, the goldfish, and the canary, belongs in the monophasic category, whereas the baby, the mouse, and the rabbit are polyphasic. Szymanski does not consider cycles of daylight and dark a sufficient cause of these rhythmic fluctuations, but he seems not to have thought of hunger as an explanatory principle.

Following the lead of Richter, Wada (127) produced fairly conclusive evidence that the infant's activity periods coincide with hunger contractions of the stomach. Irwin (60) presents confirmatory evidence that hunger stimulates activity of the newborn. His infants were most active just before the feeding hour, and were considerably less active after it. His observation of daily fluctuations in activity, from a high period in the early morning to a low period around noon, are to be compared with Szymanski's polyphasic theory.

Types of Activity. Irwin has made the most complete study of the newborn's activity. He obtained continuous records on four babies over a ten-day period, using both the mechanical and the observational methods of recording. The data were treated in three ways: according to the

percentage frequency of movements of the various body parts, e.g., leg movements/total movements, according to the frequency of movements per hour, and according to the number of oscillations of the mechanical pens per minute. Computations of the first two types yielded the fact that activity in the anterior segments of the body dominates over that in the posterior segments on every day except the first, and that the head end gains in dominance over the extremities throughout the entire ten days.

Activities of the newborn fall into two general types: mass activity and specific or segmental movements. Mass activity consists of a generalized squirming or jerking in which several parts of the body move simultaneously and too rapidly for the experimenter to observe and record them. Segmental movements are those in which a single member is moved—the head, the trunk, or the leg. These are slow enough for the human observer to note and write down in code on the moving polygraph tape.

Mass activity clearly predominates over segmental activity throughout the first ten days. Irwin writes:

> "Mass activity probably is the consequence of the neurological immaturity of the newborn infant. What are usually designated as reflexes and behavior patterns may be later specialization or individualization of mass activity."

In support of this theory he cites the work of Coghill (27) who has demonstrated that in *Amblystoma punctatum* integrated functioning of the organism as a whole precedes specific movements of its parts. Irwin also mentions that Minkowski's small fetuses exhibited a more diffuse activity than the larger ones. In more recent papers Irwin (61) presses the point that reflexes differentiate out of the matrix of mass activity. He further suggests that the organismic hypothesis of differentiation should supplant the reflex-arc theory as an explanatory principle in behavior development.

The decreasing frequency of "impulsive movements" did not escape the all-seeing eyes of Preyer. He writes:

> "It is worthy of notice that impulsive movements, which outnumber others at birth and perpetually appear in the newly-born diminish even during the nursing period, and withdraw in proportion as the will develops, until finally, with ever-increasing voluntary inhibition of the original youthful impulse of movement, such muscular activity appears in the adult, almost solely in dreamless sleep."

Pratt, Nelson, and Sun (90) present further evidence of the diffuse activity of newborns in response to specific stimulation. General restlessness was the baby's typical reaction to having its nose held; the specific defense reaction of hitting the experimenter's hand comprised only 1 per cent of all the reactions. Similarly, Shirley (104) obtained a wide variety of responses, many of them involving the entire body, in response to a light pinch of the infant's knee. Curti (34) cleverly measured her little daughter's progress in reaching for a toy in terms of the number of

kicks she made, rather than in terms of the number of successful grasps. These accessory movements of the feet decreased as the baby achieved skill in the use of her hands.

Thus from the literature on fetal and infant activities three important principles stand out clearly: (*a*) In common with all living protoplasm, the infant, before birth and after, exhibits a high degree of activity. (*b*) The stimulus to this activity is internal; hunger is one of its more important drives. (*c*) Diffuse or mass activity is the earliest type of activity to arise; specific reflexes and pattern responses apparently differentiate later from this "matrix" of mass activity.

Reflexes and Pattern Responses of the Newborn

Some differentiation of specific responses takes place before birth. Minkowski (81) and Bolaffio and Artom (14) report coordinated movements of the limbs in the larger fetuses. Indeed, the latter investigators observed bilateral arm movements in response to percussion of the table in a fetus only 5.5 cm. long. Peiper (87) noted the presence of the pupillary reflexes to light, the clasping reflex, and asymmetric tonic neck reflexes, similar to those observed by Magnus in cats, in premature infants weighing from 1000 to 2000 grams.

Preyer observed a large number of reflexes in his son shortly after birth, including six different types of oculomotor reflexes. The other baby biographers publish lists similar to his. A more complete catalog of reflexes in the newborn was made by Blanton (13).

We shall confine ourselves here to two of the more spectacular reflexes, the "grasping reflex" and the "creeping reflex." Darwin and his followers have made much of the evolutionary significance of the grasp reflex. Watson (130) tested the strength of the response in 100 babies and found that the majority of them were able to support their own weight or a trifle more with either hand up to the age of three weeks. He estimates that the reflex disappears around 120 days. Bauer (9) called attention to the creeping phenomenon in the newborn. If the experimenter lays the infant prone on a table and places his hands against the baby's foot-soles, the child's vigorous kicking will send him scooting along the table a few inches. Pressure on the soles is, according to Bauer, the adequate stimulus for this response. Shirley (103) notes that one baby kicked so hard against the examiner's abdomen that she shoved the light canvas bath table on which she was lying about 6 inches.

The baby, then, enters the world with the capacity for exhibiting a great amount of mass activity and a fair assortment of reflexes. On the basis of these he must develop the many controlled and well-directed acts that he is able to execute at two years.

The Sequence of Motor Development

Whether development proceeds in a haphazard fashion, one behavior item after another springing into existence as chance or experience dic-

tates, or whether it unfolds in an orderly sequence that is consistent from baby to baby is a question of great theoretical and practical importance. Shirley (102) has set up some criteria for establishing a behavior sequence, and for testing its reliability and validity. Her two-year study of a group of Minneapolis babies enabled her to work out the motor sequence in considerable detail (103, 104).

Description of the Sequence. The essentials of the motor sequence are presented in Table 1. The eyes are the first organs to come under muscular control. Within the first week they make fleeting attempts to catch sight of a moving light or bright object. By two or three weeks they focus on the mother's face or on her hands, or on a toy that is held within visual range. The eye-following reaction is then mastered, first for following objects that move horizontally before the eyes, then for vertically moving objects, and finally for those that swing in a circle. Jones (65) first established this order for the development of eye-movements. A more complete analysis of eye-movements by McGinnis (76) indicates that in their motor control over the eyes babies have reached essentially the adult level by the age of twelve weeks.

Simultaneously with the development of eye control the muscles of the head and neck gradually become stronger and the baby lifts his head high enough to free his chin when he is lying prone on the table. Before three months he is rearing his head and chest, propping upon elbows and hands in the prone position. He requires less and less support at the nape of the neck and shoulders to hold his head erect when he is carried at the mother's shoulder. By the end of the first quarter-year he has the muscles of his eyes, head, and neck well under control.

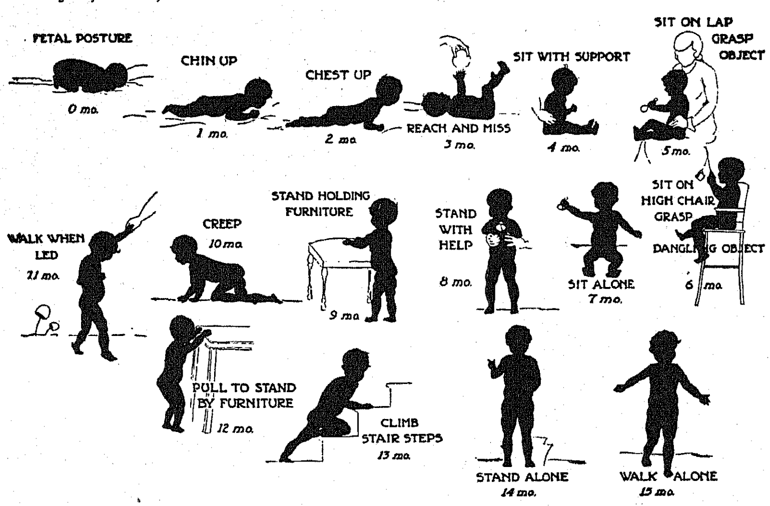


FIGURE 2

THE MOTOR SEQUENCE

(From Mary M. Shirley's *The First Two Years, a Study of Twenty-five Babies: Volume II, Intellectual Development,* frontispiece. By permission of the publishers, The University of Minnesota Press, Minneapolis, Minnesota.)

TABLE 1
THE MOTOR SEQUENCE
From Shirley (104)

Median age	Eye coordination	Locomotion	Fine motor	*Motor play*	under control Portions of body
6 days	follow light				
2 weeks	watch person				
3 "		chin up			eyes, head, and neck
5 "	follow tape H.				
9 "	follow tape V.	chest up		smile at person	
10 "	follow tape C.				
14 "		adjust for being lifted	reach and touch		arm, and upper trunk
15 "			grasp object	play with hands	
18 "		sit on lap	retain object (thumb opp.)		
21 "			grasp dangling object	object to mouth	
25 "		sit alone momentarily	transfer object (hand to hand)	play with toes	hands, and lower trunk
28.5 "		roll		pat toy	
30.5 "		sit alone 1 min.		rock, shake head	
31.5 "		stand with help			
38 "		some progress prone		suspension bridge	
41 "		scoot backward		pat-a-cake peek-a-boo	
42 "		stand holding to furniture	point with index finger		pelvic region, legs, and fingers
45 "		creep			
45 "		walk when led			
47 "		pull to stand by furniture	open simple boxes		
56-62 "				put fingers into holes	
62 "		stand alone			
66 "		walk alone		run, climb	

Motor control then moves down to the shoulder, arm, and upper trunk region. The baby begins to make anticipatory shoulder adjustments and to lift his head and strain forward when his mother bends over him to pick him up. He looks at his waving hands, and he makes passes at objects that are offered him. After a week or two he touches and grasps the objects. Stationary objects, such as a rattle held steadily in the parent's hand, he obtains at an earlier age than toys that dangle over his crib at the end of a string. By the time he is sitting securely on his mother's lap or propped with a pillow in his carriage, he is also grasping and retaining the toys placed before him.

Then the conquest of his lower trunk and legs begins. He sits alone momentarily on the floor, with legs widespread and leaning far forward, thus giving greater support to the lumbar and pelvic regions of the spine. In this position he sees his wiggling toes and he seizes them as playthings. In the prone position he kicks and squirms, and sometimes worms himself along a few inches by movements similar to those of the breast-stroke swimmer. On his back he kicks up his heels, grasps his toes, perhaps, and rolls to his side or stomach. In a short time he is able to sit unsupported on the floor for a minute or longer. If he is held erect with his feet touching a table or the floor he no longer prances and dances, but he straightens his kneejoints, plants his feet firmly, and makes two neat little footprints.

He then makes strenuous efforts to creep; but he has great difficulty in lifting his heavy abdomen and pelvis off the floor. Since babies of this age usually have rotund little figures, they not infrequently use their bulging chests and abdomens as a rocker when they are lying prone on the floor. Sometimes they pivot in the prone position. Characteristically the next step is scooting or sliding backward. Divorcing the index finger from the other digits for pointing, touching and picking up small beads or pellets is a manipulative act that puts in its appearance in the midst of these efforts to creep. Standing with the support of a stool or chair precedes the act of successful creeping.

At last the baby achieves independent locomotion by creeping or hitching, and he is soon traveling all over the house under his own steam. Simultaneously, he begins to walk when an adult leads him, first by both hands and later by one. His next achievement is pulling himself to the standing posture in his crib or beside a chair or table; and soon he walks alongside the davenport or bed, clinging to it for protection from falling. Lowering himself from the standing to sitting position marks the end of this period of rapid development in the lower pelvic region.

Finally, after an interval of several weeks, the baby stands and walks alone; and shortly after he runs and climbs steps.

During the second year his manipulative reactions become more skillful. He opens simple boxes, unscrews the lids of jars, puts pegs into holes, scribbles, then draws a straight line on paper, turns the leaves of books one at a time, and builds a tower four or five blocks high. By his second

birthday he has achieved a fair degree of control over his entire body musculature.

Motor Play. The appropriateness of the baby's play activities to his stage of motor development is evidence of the validity of the sequence. Smiling at persons and exploratory looking around develops shortly after eye control is established. Playing with the hands occurs in the early stages of reaching; if the baby misses his rattle but clasps his other hand he plays with it contentedly and ceases to struggle for the toy. Playing with his toes is just as definite a step in the sequence as is creeping or walking. It consistently appears shortly before the acts of rolling and sitting alone. Poking fingers into holes and prying at cracks are manipulative acts that follow the independent use of the index finger. In short, the baby plays at the level of his motor accomplishments, neither beneath nor above them; his spontaneous play is an adequate index of the stage he has reached in the motor sequence.

Consistency of the Sequence. Shirley (104) measured the consistency of each baby's sequence with that of the median in two ways: by computing the percentage of items that were reversed in the order of development and by correlating the individual sequences with the median. She found less than 15 per cent reversals in the order of motor items that were developed within six weeks of each other. The correlation between each baby's sequential order in 42 motor items and that of the median yielded coefficients that ranged from .93 to .98; 60 per cent of them were .97 or above.

The Motor Sequences as Recorded by Biographers. The biographical studies represent the only other source of material on the course or order of motor development. Experimentalists are wont to criticize these accounts on the grounds that the children studied represent a selected and probably a superior group, advanced both in mental and motor development; that the observers for the most part did not use systematic methods in testing their babies, but recorded merely the spontaneous reactions; and that the descriptions of the baby's performance are frequently vague and vary so greatly from one biographer to another that it is impossible to combine their results.

These deficiencies in the biographical studies do not, however, diminish the value of their contributions to the sequence of behavior development. For if a sequential order can be proved to exist it should hold as consistently for superior children as for average and inferior. Furthermore, if the sequence represents a normal unfolding of developmental processes, then it should be manifested in the baby's spontaneous behavior as well as in his reactions to such simple motor tests as those given by Shirley. Finally, the more divergent the parents' methods of observing and recording their babies' acts, the more significant are those facts that are consistent from one study to another. The biographers are almost the only ones who have used the longitudinal approach to the study of infancy; and the longitudinal approach is the only method that is adequate to solve the problems

TABLE 2

MOTOR ITEMS REPORTED BY EIGHTEEN BIOGRAPHERS COMPARED WITH THOSE REPORTED BY SHIRLEY AND BÜHLER

Reaction	Biographers Number reporting	Biographers Age in weeks Median	Biographers Age in weeks Range	Shirley Age in weeks Median	Shirley Age in weeks Range	Bühler Month of development
Focus on person or object	8	2	1-4	2	1-11	—
Lift chin, prone	3	3	3	3	1-10	2nd
Follow moving person	5	4	2-8	5	3-11	—
Lift chest, prone	3	8	8-9	9	2-19	3rd
Notice own hands	5	13	12-16	—	—	—
Reach and grasp	11	16	12-20	15	11-18	—
Sit propped or on lap	7	16	14-17	18	13-23	—
Play with toes	6	21	17-28	25	16-38	—
Roll	7	26	24-32	29	20-36	6th
Sit alone on floor	7	33	27-39	31	25-35	8th
Scoot backward	5	38	36-38	39	29-47	—
Point with index finger	5	40	39-50	41	29-50	—
Stand holding to furniture	5	41	35-46	42	33-49	—
Creep	9	46	39-56	45	32-50	8th
Walk when led	4	48	47-52	45	25-72	12th
Pull to stand by furniture	7	48	44-51	47	33-52	11th
Stand alone	5	57	45-75	62	49-76	12th
Walk alone	11	62	52-75	66	50-76	—

of sequence in developmental events. Only by following a single baby or a number of babies for a considerable length of time is it possible to make a detailed analysis of the sequence.

Eighteen biographers, namely, Champneys (24), Darwin (35), Dearborn (36), Dix (37), Fenton (42), Hall (52), Hazzard (54), McLeish (79), Major (75), Moore (82), Myers (84), Preyer (91), Rasmussen (94), Shinn (99, 100), Simpson (107), Sully (112), Tiedemann (83), and Warden (128), describe some bits of behavior adequately enough to justify combining their results for working out a sequence. The pictures of motor development that they present are gratifyingly consistent. It is impossible to make adequate comparisons among the writers without quoting them in greater detail than this chapter warrants.

Some indication of the consistency of the biographical records with the sequence outlined above is given in Table 2. Eighteen items were described sufficiently well by three or more biographers to be entered in the tabulations. No biographers reported all eighteen items. Shinn reported sixteen, the largest number, and Tiedemann, only one, the smallest. The median and age ranges on these items compare very closely to those of Shirley, and also to the month of development reported by Bühler (19). The sequences in all cases are identical.

Interpretation of the Sequence. That motor control sweeps downward from the eye and head region toward the lower trunk, pelvic, and sacral regions, and that it progresses outward in the limbs, from shoulder to finger-tips, and from hip to toes, is the most significant generalization to

be drawn from the sequence. The ever-alert Preyer was aware of this fact; so, too, were many of the other biographers. Preyer says:

> "It must be noted that the bilaterally symmetrical movement of the facial muscles and of the arms in reflexes appears very much earlier and is more pronounced than that of the legs. And the abductions, adductions, supinations, and rotations of the arms unquestionably appear plainly at an earlier period than do those of the legs in manifold variety."

Champneys also writes:

> "The arms were far more purposive in their movements than the legs from the very first."

And Darwin in similar vein:

> "The intentional movements of the hands and arms were thus much in advance of those of the body and legs; though the purposeless movements of the latter were from a very early period usually alternate as in the act of walking."

Shinn neatly demonstrated that muscular control of the head is achieved earlier than that of the hands by comparing the ages at which the mouth and the hands were used in grasping. Lips and tongue, according to the tabulation (99, Table 4), exhibited a "special passive sensitivity" to objects in the first week, whereas the hands did not show this sensitivity until the tenth week. The lips grasped the nipple on contact in the fourth week; not until the tenth week did the hands grasp the objects with which they came in contact. The head groped to grasp at five weeks; the hands at twelve. The tongue actively touched objects at seven weeks, and the fingers at twelve.

In a preliminary report of her work on muscular control, McGraw (77) further confirms the cephalocaudad direction of motor progress in babyhood.

The Motor Sequence in Animal Infants

The motor sequence takes on an added significance by virtue of the fact that it appears in a very similar form in the development of young animals. That for the infant chimpanzee studied by Jacobsen, Jacobsen, and Yoshioka (62) was almost identical with the sequence for the human infant. Baby Alpha, however, progressed from stage to stage more rapidly than the human babies. Furthermore, the chimpanzee's motor play, like that of the baby, fits neatly into the sequence. Both little Alpha and the infant ape observed by White (137) enjoyed their toes as playthings at the appropriate stages of their development, and Alpha demonstrated her control over the index finger by using it to trace the grain of the wood in the door-casings, and to follow the cracks in the bark of trees.

The young Macacus rhesus monkey observed by Lashley and Watson (70) developed eye-following and head-holding reactions among his first responses, and thumb opposition, picking up objects, and crumpling paper

appeared later. In the monkey, however, crawling, walking, and running were perfected before the manipulative reactions with the hands. Tinklepaugh and Hartman (118) note that the monkey's flexors are more highly developed than the extensors at birth, and that the infant Macacus can support more than double his weight by one flexed arm, though he can walk and stand with difficulty.

The developmental order in kittens has been observed with great care by Tilney and Casamajor (117), Windle (138), Langworthy (69), and Coronios (30). The righting response, which involves rotation of head and shoulders followed by rotation of the trunk and pelvis, occurs a few moments after birth. Coronios finds that these movements develop between the twenty-fifth and thirtieth fetal days. As the gestation period advances, according to his observation, the fetal movements change from diffuse general responses to individual movements of the body parts in response to definite stimulation; and for the most part the fetal behavior proceeds in an anterior-posterior direction. Newborn kittens achieve eye control, Tilney and Casamajor reported, late in the second week, or about one week after their eyes are opened. Backward crawling, sitting, walking, scratching, righting the body in the air, running, climbing, and playful pawing follow in their turn. Windle calls attention particularly to the superiority of the forelegs over the hind legs in strength and skill of movement in the early weeks.

The sequence for the rabbit, outlined by Kao (66), the guinea pig, observed by Avery (6), and the rat fetus, studied by Angulo y González (4), all show the operation of the cephalocaudad law in the development of motor behavior. Even in the Amblystoma, whose motor development Coghill (26) has closely observed, head flexion precedes coil movements, and coil movements precede serpentine movements; here again motor control progresses tailward.

The consistency of the motor sequence in animals with that in babies is important for two reasons. First, on the theoretical side, it is just so much added evidence that development of the human infant proceeds in accordance with far-reaching biological laws. It is no longer necessary to point to the grasp reflex, as Darwin did, or, with James (63), to cite spectacular instances of babies who pick up objects from the floor with their mouths, or, as Hrdlička (59) does, to call particular attention to those who run on all fours, in order to establish the kinship of man to the animals. Far more dramatic and conclusive evidence of the relationship is this orderly unrolling of motor function that takes place in human and animal infants in accordance with the important biological law of *developmental direction.* Secondly, the consistency of human and animal sequences is important on the practical side, for it means that physical, anatomical, and neurological foundations of the sequence may then be worked out on animal subjects rather than on human specimens. Whatever physical correlates are obtained between structural development and motor function in animals we may be fairly sure will hold with equal validity

for the baby. Also, we may submit the animal infant to more drastic environmental changes and to more strenuous training procedures than we should be willing to try on the baby. So it will be possible to obtain important evidence concerning the modifiability of the sequence, or the possibility of distorting it.

The Rôle of Maturation in Motor Development

Criteria of Maturation. Thus we have in the sequential method, because of its equal adaptability to both human and animal development, a splendid tool for attacking the nature-nurture problem in general and that of maturation in particular. (See 102.) Before launching upon an evaluation of the evidence concerning maturation it may be well to consider briefly a few criteria that have been proposed as tests of maturational development as opposed to development by chance, training, or incidental practice. The first criterion is the existence of a sequence consistent from baby to baby and from one environment to another. The second is that the speed at which development proceeds does not alter the sequence. A third criterion of maturation, and by all odds the most adequate one, is appearance of the behavior without training, and under conditions in which the child or animal is deprived of opportunities for incidental practice. Almost equally valid is the fourth criterion, that of conformity of functional development to the biological laws of structural development. A final criterion, and one which is less adequate and harder to ascertain, is that of a sudden appearance of new behavior items. For if the development of function waits upon the development of structure then one may assume that a behavior item that suddenly puts in its appearance has done so because the underlying structures have reached the minimum essential degree of development for its manifestation.

As we have seen from foregoing paragraphs on the sequence, the first two criteria of maturation are satisfied in the baby's motor development. Deprivation of practice is a somewhat more difficult criterion to test, for it is almost impossible to keep a healthy active baby from exercising his motor accomplishments. James (63), after quoting Spalding's work on swallows, expresses his eagerness for similar methods to be used for studying the baby's "instinct" to walk.

> "In the light of this report," he writes, "one may well be tempted to make a prediction about the human child, and say that if a baby were kept from getting on his feet for two or three weeks after the first impulse to walk had shown itself in him,—a small blister on each sole would do the business,—he might then be expected to walk about as well, through the mere ripening of his nerve centers, as if the ordinary process of 'learning' had been allowed to occur during all the blistered time. It is to be hoped that some scientific widower, left alone with his offspring at the critical moment, may ere long test this suggestion on the living subject."

Co-Twin Control Method. Without recourse to such method, weighty evidence favoring the third criterion has been amassed by Gesell and

Thompson (50) by means of their co-twin control studies. Elsewhere in this volume Gesell has called attention to the possibilities of this method for studying the relative rôles of maturation and practice, and has outlined the method and summarized the results of the study. The trained twin, whose daily practice in stair-climbing began at forty-six weeks, needed help in scrambling up the experimental staircase for the first few weeks. At fifty-two weeks, after six weeks of practice, she made the ascent in 26 seconds. A week later her identical twin sister who was tested for the first time mounted the flight in 45 seconds without any assistance. Two weeks of practice begun at this age brought *C* to a point of skill at fifty-five weeks that far outstripped the achievement of the long-practiced *T* at fifty-two weeks. "The maturity advantage of three weeks of age must account for this superiority," Gesell concludes.

For clear-cut results on the problem of maturation this method cannot be too highly recommended. Its only drawback is the practical one of finding enough sets of identical twins on which to experiment.

Neurological Development Correlated with Motor Functions. The bulk of the data satisfying the fourth criterion of behavior development through maturation comes from work on animals. The reason is obvious. Definite determinations of anatomical and especially of neurological growth usually involve sacrificing the animal. About the time Preyer published the biography of his son, Flechsig made his discovery that not all nerve fibers are myelinized at birth, and propounded his theory that nerves become functional only after they have developed this protective sheath. This theory naturally served as a starting-point for a great deal of work on the neurological correlates of sensory and motor function.

Lui (74) was among the first to attempt a study of the neurological basis for walking. Cleverly he made use of the fact that different animals begin to walk at different stages of their life-cycles. He chose as his experimental material the lamb, which walks at birth, the puppy, which walks at about three weeks, and the human infant, in whom walking is well established around eighteen months. Believing the cerebellum to be the center for postural and locomotor coordinations, he made it his point of attack, and studied specimens from all three animals at birth, and progressive series for the puppy and infant up to the age of walking. He observed that the external granular layer gradually disappeared, the molecular layer increased in thickness, and the Purkinje cells changed from a pyramidal to a globular shape. These changes had taken place in the infant's cerebellum by eighteen months; within the first few weeks corresponding changes had taken place in the dog's cerebellum; but the lamb's cerebellum showed such complexity at birth. Oppenheim (86) likewise stresses the immaturity of the infant's cerebellum as a reason for his inability to walk as early as he grasps.

Tilney and Casamajor (117) have shown the importance of myelinogeny in behavior development of cats. Angulo y González (4), however, believes that a certain amount of activity in rats takes place before myelinization is complete. But there are other important neurological correlates of function. Among these are the stimulability of the motor cortex.

Langworthy (69) found the foreleg region of the motor cortex in the kitten responsive to electrical stimulation at an earlier age than the hind-leg region. He also showed that myelinization of the cord proceeds in the cephalocaudad direction. Windle's (138) studies have shown that the multiplication of fine fibers in the cervical cord is concomitant with the establishment of control over the foreleg region, and that the improved control of the hind legs, which comes two weeks later, is accompanied by similar changes in the lumbar region of the cord.

Hence from these studies there is ample evidence that the development of motor control, both in animals and in humans, is dependent to a large extent upon neurological growth.

Other Anatomical Correlates. Other possible anatomical correlates with motor development may be mentioned. Changes in body form probably have their influence. It is well known that the center of gravity gradually shifts downward from a position near the end of the sternum in infancy to one low in the pelvis in the adult. Shirley (103) suggests this, in addition to the increasing ratio of leg length to trunk length and the decreasing ratio of weight to height, as probably bearing on the age of walking alone.

Wolff (139) made a study of the development of impulse points on the child's foot as skill in walking progressed. The first point to appear was on the heel, the second on the ball, the third on the side of the foot, and the fourth and last on the big toe. Hohlfeld (58) writes concerning the decrease in height that ensues when the baby begins to stand. These two anatomical correlates are more likely the effects rather than the causes of motor development.

Variot and Gotcu (122, 124, 125) have studied the influence of weight, height, and breast-feeding on the age of walking. They find age a more important factor than either weight or height in the onset of walking. Infants that are entirely breast-fed walk about a month earlier than those partially or wholly bottle-fed, according to their results.

The importance of the growth of muscular tissue and bones in the development of motor function should not be overlooked. Halverson (53) calls particular attention to this phase of maturation in his monograph on prehension.

Suddenness of Motor Development. Most of the statements in support of the last criterion of maturation come from notes made by the biographers. Preyer writes:

> "Suddenly—on the 457th day of his life—the child can run alone. The day before he was entirely unable to take three steps alone,—he had to be led if only by means of a stick, perhaps a lead pencil. Now, he ran alone around a large table, unsteadily indeed, and staggering and not holding his head in a stable position, but without falling."

James writes in a similar vein:

> "Yesterday the baby sat quite contentedly wherever he was put;

today it has become impossible to keep him sitting at all, so irresistible is the impulse, aroused by the sight of the floor, to throw himself forward on his hands."

The tale of Hall's little daughter who, after drawing on her father's cuffs, suddenly and proudly strutted about the room, and who was for several days unable to walk without the facilitating influence of these now outmoded masculine adornments, has found its way into many textbooks. Baldwin's (8) little girl showed the "walking reflex" (alternate stepping movements) quite suddenly in the ninth month. And Simpson's (107) son

> "walked quite suddenly. Till the day he succeeded a tendency to fall back deterred him from trying. The day he did it his hands happened to be out in front of him. For some time after his success he could only walk with them in this position."

Fenton (42) tells of her son's first walking across a neighbor's living-room to examine an interesting carved chair when she and he were making a call.

Other writers speak of rhythms in motor development. Moore (82), in commenting on the four periods of rapid progress that she noted in her son, says:

> "In looking for an explanation of the periods these facts would seem to point away from a field of causation wholly external to the child. Perhaps like a clay modeler who works by terms upon each portion of the figure he is moulding, and finds his model finished as if by magic beneath his touch, the child, experimenting now here, now there, gaining control first in one direction, then another, one day surprises his elders by a display of knowledge and ability of which they had not supposed him possessed."

Shinn (101, p. 141) makes a similar comment:

> "She sprang into this era (of handling objects) suddenly, within four days. It was not infrequently thus, and perhaps more and more as the little brain grew complex. Some power that had been slowly developing would leap into completion, unlocking a dozen other doors of mental life."

Tanner (114, p. 351) discusses growth rhythms thus:

> "In describing these stages in locomotion we have proceeded as if growth were continuous, but as a matter of fact it is not. Some movement will appear, be practiced for a day or two, and then be neglected for several months. Then suddenly it will reappear and be practiced diligently until it is learned. Walking is likely to be interrupted by the beginning of speech, and vice versa, so that the two processes of learning to walk and learning to speak, which stretch over several months have periods of waxing and waning."

Shirley (103, 104) not only cites examples of sudden appearances of new motor acts, but also plots individual developmental curves and adduces

other evidence to show that behavior development is far from continuous and regular in its rate during the first eighteen months. In the latter part of the second year, according to her results, babies become more consistent and regular in their performance. She clarifies the issue concerning suddenness of behavior by speaking of two types of development, the emergence of new behavior items, and the improvement of old items. That new behavior never emerges at a level of high proficiency or at the "physiological limit" is an easily understood fact. Even in reflexes and pattern responses that emerge in a complex form there is always room for improvement through practice.

Opposed to these statements of careful parent observers and these experimental results we have the work of Thompson (116) who found behavior increments in Twin *T*'s responses to the cubes almost every day. Behavior increments consisted in greater frequency of one item of behavior, improved performance of that activity, appearance of a new activity, and integration of previous activities. The third type of increments represents development through emergence, which is the only phase in which suddenness would play a part. The other three represent improvement through practice. McGraw (78) says there is no indication of sudden maturation of function in the development of motor control in infancy.

Summary of Maturation in Motor Development. With the possible exception of the last, the five criteria of maturation are adequately satisfied by the observational and experimental data on the acquisition of motor control in babyhood. A consistent sequence of motor items unrolls at varying speeds but in an unvarying order that is little influenced by specific training or by divergent environmental factors. The unfolding of motor skills proceeds in accordance with biological laws. The chief one is the *law of developmental direction* or the anterior-posterior growth law. A second law is that of *priority of the flexor muscles over the extensors* in strength. A third law of neural and muscular action that may be operating in cases of sudden integration of motor skills is the *all-or-none* law. [For a more complete discussion of this point see (103, p. 175).] Hence we may conclude that such an important function as the baby's muscular control is not left to the exigencies of chance, training, or incidental practice. Instead, functional development is predetermined and controlled by the same growth gradients that predetermine and control the development of body structure.

Detailed Analysis of Grasping and Walking

The foregoing conclusion, we must remember, does not rule out the effectiveness of practice and training in improving motor skills once they have appeared in the normal course of maturation. Skills do not mature at the level of perfection. The Olympic sprinter naturally began to run between the ages of one and two years; yet he would not think of competing in the international games without months of serious training in addition to the years of incidental practice in his boyhood. So, too, the

effects of both incidental practice and specific training are noticeable in the baby. Both Twin T and Twin C improved in stair-climbing during the regime of practice; and both continued to make progress incidentally after the training ceased.

Successes in reaching and grasping become more frequent as the baby persists in this behavior. Increasing speed of reaching and grasping is another sign of waxing proficiency. In order to study the improvement phase of motor development one must resort to more detailed methods of analysis than the simple observing and recording of events.

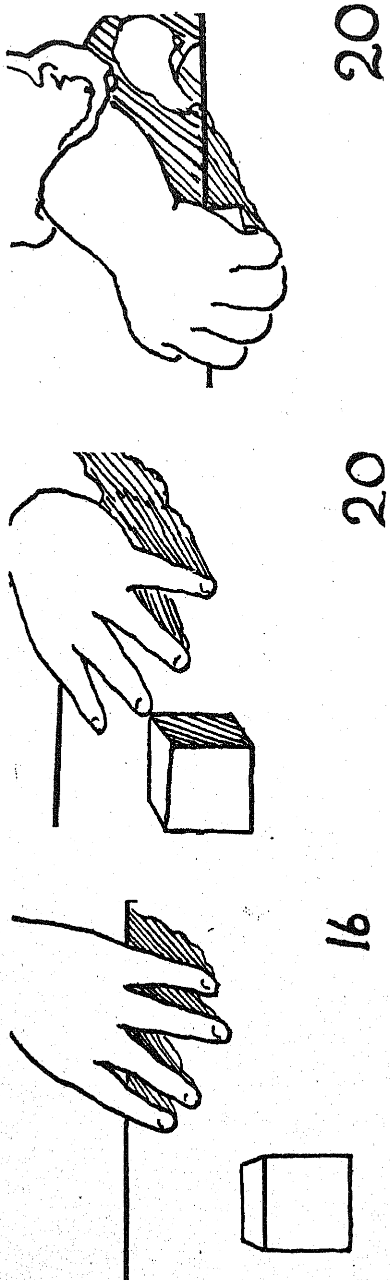
Studies of Grasping and Prehension. Watson and Watson (134) studied the development of the response of reaching for a positive stimulus —a stick of candy—and the blotting-out of the response to a negative stimulus—a lighted candle. The negative reaction, withdrawal, they found, was not established by one slight burn; the baby's fingers had to be scorched several times before she learned not to reach. This result indirectly attests the significance of biological maturation of the approach and grasp response. In the early stages of its development the reaction persists and recurs in spite of painful consequences.

Jones's (65) tests of reaching and thumb opposition served to establish age standards in these traits. Twenty-two weeks represented the fiftieth percentile of her cases in both these motor items.

The acceptance of one, two, and three objects was studied by Lippman (73). The ages at which 50 per cent of the babies accepted the objects were: first object, 4 1/3 months; second object, 5 2/3 months; third object, 9 months. He noted five ways in which the second object was accepted: by taking it in the opposite hand; by shifting the first object to the opposite hand and accepting the second with the preferred hand; by dropping the first object to take the second; by putting the first or second or both objects in the mouth; or by accepting the second object in the same hand. In accepting the third object the baby sometimes dropped one or both of the others; sometimes he transferred the objects to the non-preferred hand in order to accept the third with the preferred hand; and sometimes he accepted the third into a hand that already held one object.

From observing the reaching response of his infant daughter, Brainard (16) evolved a theory as to why the baby does not develop eye-hand co-ordination before he sits on adults' laps or is propped with pillows. When the infant is lying in his crib his visual field and his manual field overlap very little; but when he sits, the visual field and the manual field practically coincide. Hence, when he sits, the baby watches his hands and then he reaches. The reports of other observers, however, indicate that the baby often moves his hands up into the visual field and inspects them when he is lying in the crib.

So swift and complicated are the baby's reaching responses that it is impossible to record and analyze them completely by the unaided eye. Halverson (53) therefore employed the cinema technique in a study of the three-cube situation of the Gesell test. In this way he observed twelve

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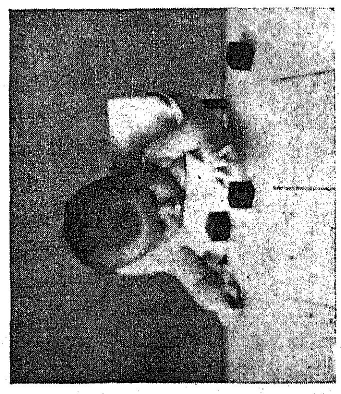
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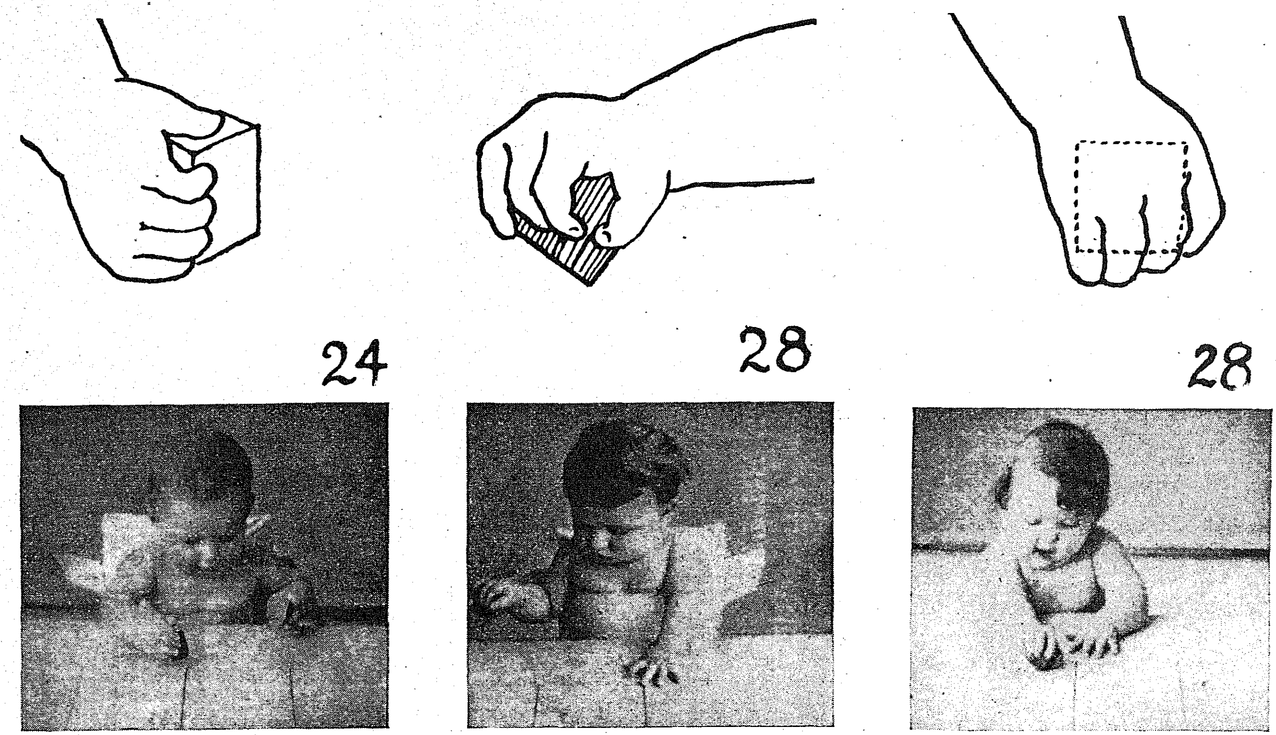
Primitive squeeze

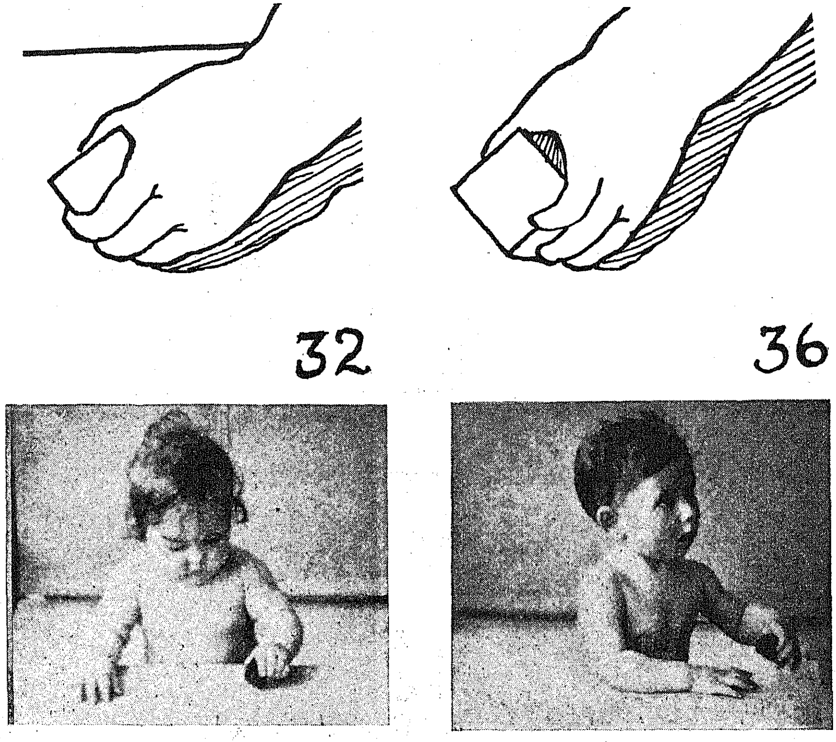


Squeeze grasp | Hand grasp | Palm grasp

FIGURE 3

TYPES OF GRASP

(From H. M. Halverson's "An Experimental Study of Prehension in Infants by Means of Systematic Cinema Records." *Genet. Psychol. Monog.*, 1931, **10**, 212-213.)



Superior-palm grasp   Inferior-forefinger grasp

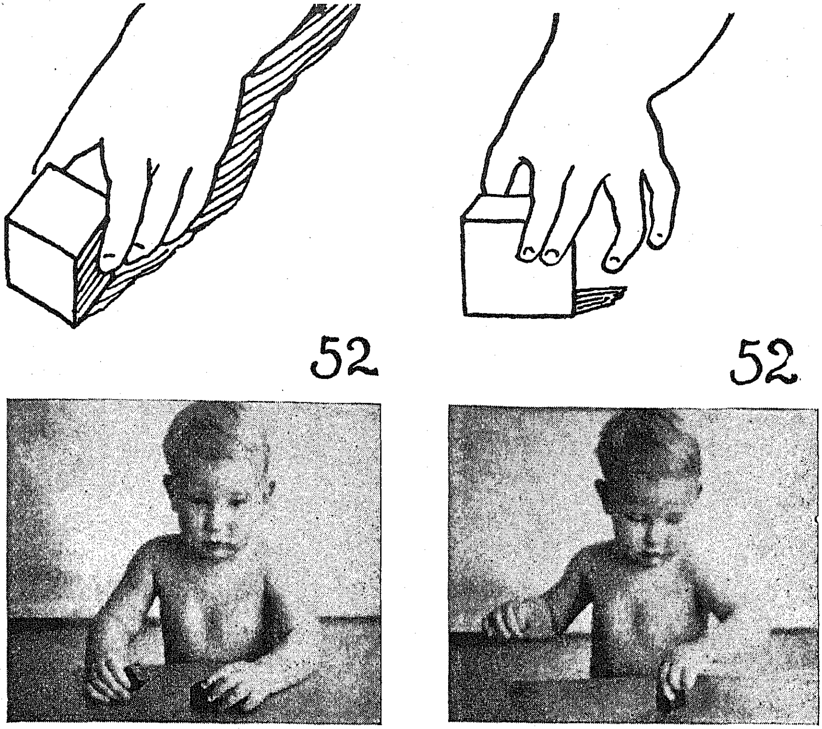
FIGURE 4

TYPES OF GRASP

(From H. M. Halverson's "An Experimental Study of Prehension in Infants by Means of Systematic Cinema Records." *Genet. Psychol. Monog.*, 1931, **10**, 214.)

or more children at intervals of four weeks from sixteen to forty weeks, and a final group at fifty-two weeks. He made frame-by-frame analysis of the regarding, the approach, and the grasp. Increasing skill was shown by increasing length of regard up to twenty-eight weeks, by an increased number of contacts and grasps, and by a decreased time before grasps and time required to grasp. There were three types of approach: the loop, most common at sixteen weeks; the slide, commonest at twenty and twenty-four weeks; and the plane, most characteristic of forty and fifty-two weeks. The type of grasping progressed from a primitive squeeze, in which the cube was pawed in and clasped by squeezing it against the other hand or the body, to the hand grasp, in which the cube was clutched with the curling fingers and held against the heel of the palm. Then came the superior-hand grasp, in which the cube gradually moved out toward the digits; and, finally, the superior-forefinger grasp, in which the cube was grasped between the thumb and the first two or three digits.

In his conclusions Halverson emphasizes the sequential pattern-like character of the progress in prehension. He calls attention to the fact that maturation in grasping proceeds from the coarser muscles of the shoulder



Forefinger grasp | Superior-forefinger grasp

FIGURE 4 (*continued*)
TYPES OF GRASP
(From H. M. Halverson's "An Experimental Study of Prehension in Infants by Means of Systematic Cinema Records." *Genet. Psychol. Monog.*, 1931, **10**, 215.)

and upper arm to the finer ones of the wrists, thumb, and forefinger. He looks to anatomical growth of the digits and the hand and increasing cutaneous sensibility of the finger-tips, as well as to neuromuscular maturation and training, as explanatory factors.

Castner (23) employed the same cinema technique and the same methods of analysis in studying prehension of the pellet. He considers it significant that regard shifts from the pellet to the hand more often than from the hand to the pellet. His other results concerning the regard and the approach confirm those of Halverson. The most primitive type of closure, that of the whole hand, rarely secures the pellet. In palmar prehension, which is characteristic of thirty-two weeks, the pellet is clamped against the heel of the hand. Scissors closure, clasping the pellet between the thumb and the side of the forefinger, is most common at forty-four weeks. Pincer prehension has developed by fifty-two weeks. Castner points out that increasing dominance and differentiation of the radial digits underlies this sequence.

Richardson (95) was primarily interested in the growth of adaptive

behavior in her experiment of string-pulling. She found, however, that ability to prehend and to pull the toy within reach increased up to forty-four weeks. The number of tugs required to bring the toy within range decreased with age. Concerning sudden maturation in this ability she writes (p. 331):

> "When sufficient maturity is reached, there are instances where new and adequate envisagement of the situation seems to make its appearance with relative suddenness and to be followed by performance of a consistently higher level."

Studies of Walking. Vierordt (126) made the first study of improvement in walking. He equipped overshoes with tiny inkwells and pens on the heel, and on both sides of the ball of the foot. Thus he obtained graphic records of the gaits of two children, one two and a half, and the other four and a half years old, and of an adult. Increased proficiency in walking was shown by an increasing length, a decreasing relative width, and an increasing angle of step.

Dix (37) studied his son's walking at fifteen months, counting the child's steps as he pattered about the house and lawn for three successive days. On the three days little Heinz averaged more than forty steps a minute, and in one six-and-a-half–hour observation period he traveled a total distance of 1 km., 660 m.

Graphic records showing the entire footprint were obtained by Burnside (22) who had the baby walk down a paper path that rested on an inked foundation. She was the first to employ the cinema method in analyzing motor skills. By camera-lucida drawings made from the original frames she depicts body posture in three stages of locomotion: crawling with the abdomen dragging; creeping; and walking. Analysis of the footprint records showed an increasing step-length and a decreasing width and decreasing variability with age.

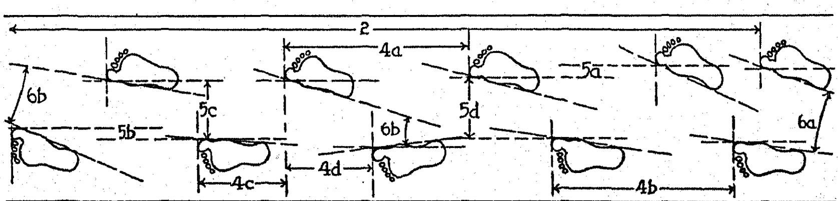


FIGURE 5

DIAGRAM SHOWING THE METHOD OF MEASURING FOOTPRINTS

(From Mary M. Shirley's *The First Two Years, a Study of Twenty-five Babies: Volume I, Postural and Locomotor Development,* p. 63. By permission of the publishers, The University of Minnesota Press, Minneapolis, Minnesota.)

Using an oil-powder technique Shirley (103) obtained graphic records of walking at weekly or bi-weekly intervals from 17 to 104 weeks. Four stages of walking development were visible in the records: first, an early period of dancing, prancing, or pawing on the toes in which the baby made alternate stepping movements, but bore no weight on his feet; secondly, a period in which he stood with help, making two neat little tracks; thirdly, a period in which he walked when led by an adult; and, fourthly, a period in which he walked alone. Complete measurement and statistical treatment of the data from more than seven hundred records showed increasing speed of walking and increasing length of step. Width of step increased until the baby walked alone, and then decreased. Out-toeing was characteristic of the early stages, but as the babies became proficient walkers their angle of step decreased and approached zero degrees.

The improvement phase of motor development is well illustrated by the results of these detailed studies of prehension and walking. Such improvement occurred, however, through spontaneous or incidental practice taken by the baby himself rather than through training at the hands of an

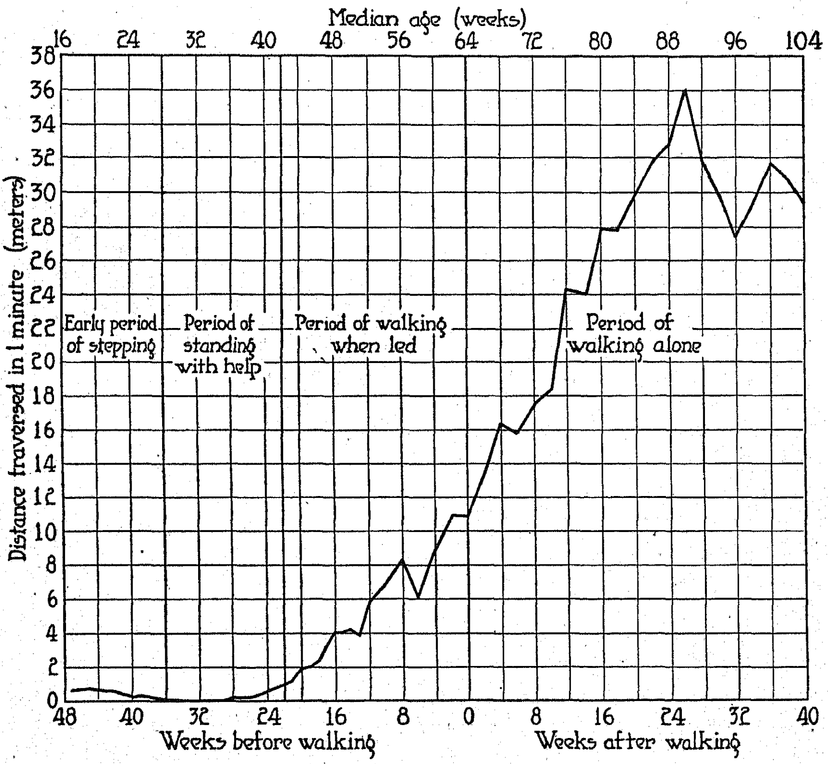


FIGURE 6

MEDIAN DISTANCE TRAVERSED IN A ONE-MINUTE INTERVAL OF WALKING

(From Mary M. Shirley's *The First Two Years, a Study of Twenty-five Babies: Volume I, Postural and Locomotor Development,* p. 72. By permission of the publishers, The University of Minnesota Press, Minneapolis, Minnesota.)

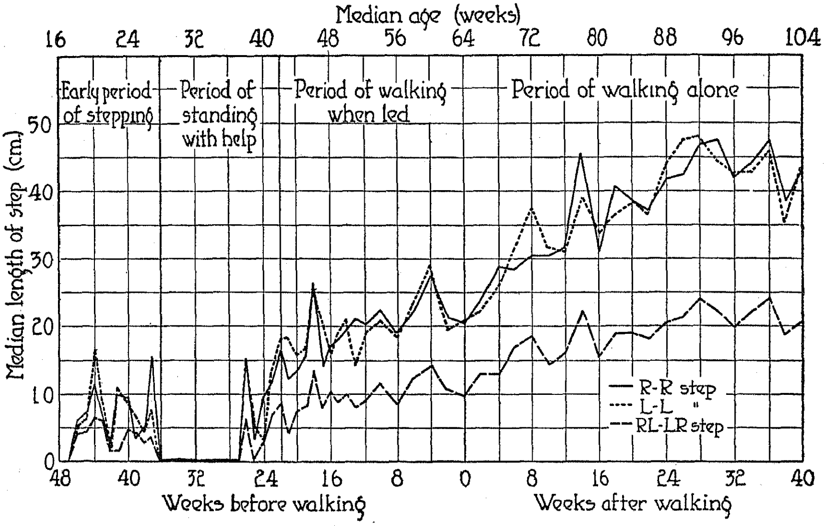


FIGURE 7

MEDIAN LENGTH OF STEP OBTAINED IN A ONE-MINUTE INTERVAL OF WALKING (UNSMOOTHED)

(From Mary M. Shirley's *The First Two Years, a Study of Twenty-five Babies: Volume I, Postural and Locomotor Development,* p. 75. By permission of the publishers, The University of Minnesota Press, Minneapolis, Minnesota.)

experimenter. In all these studies the influence of maturation is strongly apparent, both in the definite sequence or order of development that is noted in each type of behavior and in the application of the anterior-posterior growth law.

INDIVIDUAL DIFFERENCES IN RATE OF MOTOR DEVELOPMENT

All authors report wide variations in the age of development, and several have sought for an explanation of these differences on the basis of size, race, sex, and illness. The conclusions of Variot and of Shirley on the relation of size to age of walking have been mentioned above. There is some evidence that the rotund, heavy baby walks later than the child who is light on his feet, but there are many exceptions to this simple rule.

Relation of Motor Development to Race. No significant race differences have been found by any investigators. In Jones's (65) study the only notable difference between white and Negro babies was in the age of smiling, and in this response the Negroes were slightly ahead. McGraw (77) found that the following motor items were passed by a slightly larger percentage of Negro babies than whites: at two months, holding the head erect; four months, lying supported only on the hand surfaces, reaching for a touched object, grasping with both hands, and looking at a touched object; six months, manipulating a still object with a moving one, and actively seeking contact; seven months, pulling a napkin off the head when sitting with support; eight months, sitting without support on the bed. Most of the items in which the Negro babies excelled the whites were

motor items. The only motor item in which the white babies exceeded the Negroes was in locomotion (turning or rolling) at seven months.

Smith and others (108) obtained reports of walking ages on 1449 children of Iowa and Hawaii. Among the seven racial groups represented by the Hawaiians there were no racial differences in walking age. The Hawaiian babies walked about six weeks earlier than the Iowans; the authors attribute this to the warm, sunny Hawaiian climate, which affords greater opportunity for babies' growing up out of doors.

Sex and Motor Development. Most investigators report that girls walk a little earlier than boys. Hawaiian and Iowan girls were about two weeks ahead of boys in walking age. Terman (115) reports that the gifted girls walked a little earlier than the gifted boys.

Influences of Disease on Motor Development. The retarding influence of rickets on age of walking has been emphasized by pediatricians. In a study of more than seventy pairs of rachitic and non-rachitic children at the three ages of twelve, eighteen, and twenty-four months, Gesell (47) shows that the retarding effect of the disease has been somewhat exaggerated. The comparative percentages for normal and rachitic babies in the various stages of walking are shown in Table 3. Although almost as large a percentage of rachitic babies toddle about, yet their coordination is less skillful and their footing less sure than that of the non-rachitic.

TABLE 3

	12 months		18 months		24 months	
	N %	R %	N %	R %	N %	R %
Walks with help of chair	67	42	99	93	100	91
Walks alone, fair balance	15	8	96	83	98	82
Walks around house; seldom falls	7	0	57	20	96	50

From analysis of mothers' reports on 81 children who had suffered a serious illness before the age of two years, Smith (109) estimated that developmental rate is retarded about 14 per cent by illness. He found that the children who had been ill were about a month behind the healthy ones in creeping age and about six weeks behind in walking age.

Intelligence and Motor Development. Most of the correlations between early motor development and subsequent intelligence test scores have utilized the mother's report of walking age as the motor item. Abt, Adler, and Bartelme (1) report correlations of .37 and .36 for girls and boys respectively between youngness at walking and intelligence. Aoki (5) obtained a correlation of .53 between reported walking age and school marks in the early grades. These coefficients are probably high, and influenced greatly by the lower end of the distribution in intelligence. For gifted children walk only about a month earlier than children of average intelligence, whereas the average exceed the feebleminded almost twelve months in walking age (115). Lack of motor differences between Negro

and white babies is indirect evidence of a low relationship between motor and intellectual traits, for the difference between the two races in intelligence is well established.

Motor and Mental Tests

Although the relationship between intelligence and early motor development is slight, nevertheless motor items have figured largely in tests of general intellectual ability, particularly below the age of two years. Kuhlmann's (68) tests for the six-months- and year-old child are composed almost entirely of motor items. The Yale Developmental Schedules (46) also contain a number of motor items at the early ages, but after eighteen months most of these are supplanted by language and adaptive behavior items.

The low relationship between motor development and intelligence may in part account for the low reliability of mental tests given at the early months. Bayley (10), Conger (29), and Shirley (104) all report great unreliability or fluctuation in test scores below three months. Indeed, Bayley remarks:

> "There is some indication that the tests measure, at different levels, different functions whose rates of growth are independent of each other."

This factor also may partially explain the low correlations obtained by Furfey and Muehlenbein (43) between the Linfert-Hierholzer test quotients of babies under one year and Stanford-Binet IQ's at four years. In order to test the hypothesis Muehlenbein used a number of motor tests on the four-year-olds, but found no relationship between performance on them and the early quotients.

In 1911 Cruchet (31) published a series of tests for babies under two that contained a large number of motor items; but in a recent article (32) he says that the scale is erroneous and does not correspond to the temporal development of the intellect of the normal baby. Sheffield (96) included simple motor tests among his items for diagnosing backward babies, but, since he was interested only in retardation, his items are a little too easy for the ages at which he suggests their use.

Cunningham (33), the only person who has tried to devise a test for measuring motor development apart from general intelligence and physical growth, ironically enough obtained results that correlated rather high with Kuhlmann MA's. She attributes the relationship partly to the large number of motor items in the Kuhlmann tests. Her finding, therefore, does not seriously alter the general conclusion that the relationship between motor and mental traits in babyhood is positive, but far too low for the one to be used in predicting the other.

Because the great individual differences in motor development are unexplainable on other bases, Shirley (103) has suggested that motor ability may represent a *talent* that is possessed in varying degrees by different

babies. It would be interesting to know whether athletically inclined adults were precocious in their motor development during babyhood.

Summary

To three of the four questions raised by Preyer in 1880 we today have adequate and clear-cut answers. First, motor development during babyhood is not a new and novel condition brought on by the expulsion of the child into the outside world. Instead it is continuous with fetal activity; from that early mass activity differentiate first the reflexes and pattern responses, and later the controlled movements of specific body parts. Secondly, motor development unrolls in a definite sequence that holds consistently from baby to baby, and even from baby to animal young. Thirdly, the nature of the sequence clearly indicates its dependence upon biological laws of growth. But to the fourth question, concerning the causes of the great individual differences in speed of motor development, we are at present unable to give an adequate answer.

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CHAPTER 6

EMOTIONAL DEVELOPMENT

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The genetic approach, increasingly emphasized in the psychological research of the past fifteen years, has gained some of its chief successes in the study of emotional behavior. Psychologists have attacked the problem of innate emotional equipment by observing the infant's earliest responses; they have attempted explanations as to how this primary behavior is modified—how the child becomes the man, emotionally; they have studied specific emotions in infants and children, in relation to such concomitant factors as age, intelligence, and environment; they have analyzed and measured the modes of emotional expression, both internal and overt; and they have made a beginning toward a scientific consideration of the practical problems of emotional instability and maladjustment. Such studies have contributed greatly to the young and growing science of child development. They have also furnished new formulations and new theoretical concepts which have vitally affected viewpoints concerning the origin and function of emotions.

THE PRIMARY EMOTIONAL PATTERNS

The earliest systematic approach to the problem of primary emotional equipment in man was initiated by Watson at Johns Hopkins in 1917 (77). In an attempt to catalogue the behavior responses present at birth and shortly thereafter, Watson observed a number of infants in settings designed to call out emotional expressions of various sorts. No project in child study has been more widely quoted than this, and, while his findings are now common knowledge, we may repeat them here as a starting-point for further discussion. Of all the situations presented, including fire, darkness, false faces, and strange animals, only a very few aroused behavior which an observer would classify as "emotional." As a result of these observations, Watson suggested three emotions as belonging to the original equipment of infants in the first few months of life. These were named fear, rage, and love, although, to avoid undesired connotation, he suggested they might better be called *x, y,* and *z*. They were described in specific stimulus-response terms: Fear was the startle reaction to loud sound or sudden loss of support; rage was the stiffening reaction to hampered movements; love was the expansive reaction to gentle patting, warmth, and stroking of erotogenic zones. In fear, the baby responded by catching its breath, trembling, suddenly closing the eyes, clutching with the hands, puckering the lips, whimpering, and crying. Rage was ex-

pressed by slashing of hands and feet, holding the breath, crying, or screaming. The love response was characterized by stretching, spreading of fingers and toes, cooing, and extension of the arms. With this pronouncement concerning the very meager and stereotyped nature of the early emotions, Watson was prepared to reject all previous theories assuming innate fears of the dark or of animals, inborn feelings of disgust or jealousy, and natural tendencies to react to any stimuli more complicated than loud sounds, hampered movements, or pleasurable stroking.

This brief inventory of primary emotions almost at once gained a wide acceptance. Its advantage over some of the more extensive lists proposed by such writers as Ribot or McDougall was perhaps chiefly due to the clearer evidence of a first-hand empirical basis. It is of some interest, however, to note that the three emotions emerging from laboratory study closely resemble the theoretical classifications which Bain, among others, proposed in an earlier generation.

Additions to Watson's list have been suggested from certain quarters; Bekhterev (4), for example, suggests that to fear, rage, and love should be added two "somato-mimetic reflexes": a reaction denoting biological satisfaction, characterized by peripheral vascular dilation and smoothing-out of facial wrinkles, and a reaction denoting biological dissatisfaction, characterized by increased muscular energy, increased tonus of the vessels, and later by muscular unrest. From the point of view of a physiologist, Cannon (12) has accepted the primary and primitive character of such an emotion as rage, and considers that in many respects it is similar to a simple reflex: It is universal, unlearned, appears very early in life, appears promptly to an appropriate stimulus, requires a specific stimulating situation, and possesses biological utility. In his attention, however, to the expression of rage in the lower animals, Cannon may have been led to underestimate one important point: With regard both to afferent and efferent changes, the rage pattern in human beings would appear to be much more modifiable than the so-called simple reflexes.

In the Freudian (28) system the primary emotions are regarded as deriving from two sources, the "libido" and the "death instinct." According to this view the earliest stage of development is dominated by the death or destructive instinct, which is directed against inner instinctual cravings or against external persons or objects, and is expressed as fear or rage. The child's helplessness against his growing destructive impulses gives rise to a sharp sense of anxiety which underlies his earliest emotional expression. As the life instinct, or libido, increases in power, and the child's contacts with reality multiply, the anxiety-situations become less potent, and aggressive behavior becomes tempered with more social motives. The child's general development as well as his specific reactions to the environment are considered to be determined by the relative strength of the life and death instincts, and the interactions between the two.

ARE THERE ANY BASIC EMOTIONS?

Recent experimental studies of children have led to a criticism of the "specific-pattern" theory of emotional responses. The earliest emotions are described as generalized rather than as specific reactions; they are diffuse, undifferentiated and are influenced by numerous situational factors and by the readiness of the individual organism to react.

Sherman's (68) laboratory studies of infants were well designed to test the behavioristic theory of specific primary emotional patterns and Cannon's assumption of specific reflex components in emotion.

A group of qualified observers, including medical students, nurses, and psychologists, observed the behavior of infants in a number of different emotion-provoking situations, including hunger from a delayed feeding schedule, pain, sudden loss of support, and restraint of head movement. The observers were not always permitted to know what situation preceded a given response; thus a comparison could be made between the classification of behavior with knowledge and without knowledge of the stimulus. Sherman concluded from his experimental evidence that the reactions to isolated stimuli were not specialized and easily identifiable patterns appearing with uniformity in many individual children, but that they were uncoordinated, unspecialized, and diversified.

> "If we believe that the emotions are native characteristics with a predetermined pattern, we are very likely to attribute to the child emotional reactions which in reality may be merely attempts to adjust with the body as a whole to some stimulating condition. The infant even as old as six months does not show typical forms of behavior which can be characterized as definite emotions, but only generally aimless responses which can at most be called vaguely adaptive."

Sherman also pointed out that responses were more closely allied to the intensity, the duration, and the suddenness of presentation, than to the kind of stimulation.

> "In infants about two weeks of age it is possible to obtain various kinds of adaptive reactions when a given type of stimulus is varied in intensity. Thus if restraint is applied lightly to the face for a short period it produces movements of the arms and head without crying, but if applied suddenly and with intensity the response is characterized by violent kicking, pushing movements of the hands, and crying."

The implications of Sherman's study have been considered by Goodenough (25):

> "The problem attacked and in a fair way answered by these experiments [Sherman's] is not whether the entire pattern of behavior, with its usual accompaniments of verbal expression, modifications of tonal inflection, gross bodily activity, vasomotor changes, modifications of breathing, bodily tremors, and so forth, can be classified under certain general heads with approximate accuracy,

> but whether a single partial feature of the behavior pattern, such as the state of contraction of the facial musculature at a given instant in the reaction is sufficiently highly correlated with the remainder of the behavior picture to serve as an adequate substitute for it. That such a degree of correlation does not exist seems to have been satisfactorily demonstrated, but we are not warranted in assuming that the complete reaction is equally devoid of characteristic features."

The work of Pratt, Nelson, and Sun (60), who observed the behavior of newborn infants in an experimental cabinet, has tended to emphasize the predominant rôle of generalized rather than specific reactions in early behavior. This was found to be true of emotional as well as of other reactions; "entire patterns" are difficult to isolate, owing to the baffling fusion of many response elements into a very labile type of mass activity. The possibility remains, however, that finer methods of recording may reveal some specific features which are inaccessible to ordinary observation.

Klein (47), in order to test this hypothesis, has used an oscillograph to obtain graphic records of the cries of babies in diverse situations involving hunger, frustration, and startle. He states, provisionally, that the instrumental picture of the vocal responses seems to be specific for "hunger" and "fear" and "rage" stimuli, and that these stimuli call out similar specific responses in all the babies of their sample. It is clear that much further work needs to be done, particularly with children under one month of age, to provide a more adequate description of the precise (and non-precise) features of early emotional behavior.

M. C. Jones (4) has emphasized the "preparedness" of the organism as a primary factor in determining emotional behavior. In studying fear responses, she extended the observations of Watson to include older children and a wider variety of stimuli. Seventy children between three months and seven years of age were tested in situations especially designed to bring out existing fear responses. A number of stimuli, such as flashlights, mechanical toys, stuffed animals, false faces, darkness, slimy animals, and furry animals, were presented under varying conditions. These conditions included (*a*) preparing the child for the appearance of the stimulus, (*b*) arranging for the child to come upon the stimulus unexpectedly, (*c*) having the stimulus presented by a friendly adult, (*d*) having the stimulus presented by a stranger, (*e*) presenting the stimulus in the presence of other well-adjusted children, and (*f*) having unadjusted children present.

From a tabulation of the various situation-response patterns observed, it became clear that the one common factor which was present in all the fear-exciting situations was that of suddenness and unexpectedness. Under such circumstances the individual was called upon to make a quick adjustment to a strange stimulus, and often the result was a chaotic fear response. It was repeatedly observed, for example, that a frog was

more startling than any other animal because of its propensity for jumping unexpectedly when the child reached out to touch it. Likewise, children tended to withdraw from a white rat if they came upon it in their box of toys, while they would accept it readily if it was handed to them by an adult in whom they had confidence.

That loud sounds are not invariably terrifying may be taken as further evidence that the preparedness of the organism and not merely the physical aspect of the stimulus needs to be considered. English (18), for example, was unable to condition his fourteen-months-old child to an extremely loud sound, since the sound failed to function as a primary stimulus to fear. The child was placed in a high-chair (her own) and was left alone in the laboratory. A wooden duck, not previously seen by the child, was lowered from the ceiling to a position directly in front of her. As she grasped the duck, a large metal bar behind her head was struck a resounding blow, and a motion-picture camera recorded facial expression and bodily movement. The ineffectiveness of this violent stimulus can perhaps best be explained if we take into account such factors as the child's "confidence" or "adjustment" to the general situation.

In line with the foregoing, Bridges (8) has concluded, from an extended observational study of the emotional behavior of infants and preschool children, that "there is probably an original undifferentiated emotion of excitement." Early in infancy, "distress" and "delight" become differentiated and these two in turn furnish the source, on the one hand, of anger, fear, and other emotions of avoidance and aggression; on the other hand, of joy and affection. Bridges conceives of her theory as an extension and modification of those previously offered by Watson, Dashiell, and by Stratton.

The Growth of Emotional Processes. Although our information as to the exact emotional repertoire of the newborn is still incomplete, it is evident that infantile emotional responses are markedly different from those at later stages, and that modifications of the original behavior may be noted from a very early age. The manner in which these differentiations are effected has been the subject of a number of investigations. Since the present available interpretations fall into two main categories, and since the evidence for each seems indisputable, we may assume that the basic emotions, whatever they may be, attain more sophisticated and varied expression partly through maturation and partly through learning.

The Rôle of Maturation. The rôle of maturation in altering emotional patterns is emphasized by H. E. and M. C. Jones (38). As the result of one of their experiments in which a snake of a harmless variety was used as a stimulus, they found, in a group of about fifty children and ninety adults, that children up to the age of two years showed no fear of a snake; by three or three and a half, caution reactions were common; children of this age paid closer attention to the snake's move-

ments, and were somewhat tentative in approaching and touching it. Definite avoidance behavior occurred more often after the age of four years, and was more pronounced in adults than in children. This "maturing" of a specific emotional reaction was given the following interpretation:

> "Fear may be regarded as a response to certain changes in a total situation: changes requiring a sudden new adjustment which the individual is unprepared to make. The arousal of fear depends not only upon situational changes, but also upon the individual's general level of development. With a young infant, perhaps the only changes which are fear-producing are those which substitute loud sounds for quiet, pain for comfort, or loss of support for a previous state of bodily balance. As a child develops, his intelligence innately matures, and his perceptions become enriched through experience. New things startle him because of his keener perception of the fact that they are new and unusual. . . . Fear arises when we know enough to recognize the potential danger in a situation but have not advanced to the point of complete comprehension and control of the changing situation."

Support for this view is given by Washburn (75) in a study of infants' social smiles (smiling in response to the smile of another). She reports that smiling occurred in every infant from eight to twenty weeks of age; from twenty until forty weeks the negative responses increased, after which time the smile was again easily elicited. Washburn attributed the negative phase to a period of increasing awareness of strangers.

Bayley (3) has recorded the crying behavior of sixty-one infants, observed in a series of standard situations each month from birth to twelve months of age. She reports that the frequency of negative reactions to strangers increases, up to about ten months, with developing intelligence of the children. Crying because of fear in strange situations was distinguished from other types of response as follows: It occurred when the child was brought into a strange room, or when he was taken from his mother by a strange person; it was usually accompanied by turning to and clinging to his mother; it was inhibited when he was held by his mother and when he became accustomed to the strange place and persons.

Gesell (22) also stresses the rôle of maturation in describing the emotional behavior of children in situations which are fear-producing:

> "The primary emotions have been discussed as though they were elementary, stable phenomena subject only to the changes of social conditioning. . . . Fear is not a simple entity. It waxes and alters with growth. It is shaped by intrinsic maturation as well as by experience, certainly during the period of infancy. . . . This pattern (the fear pattern) is as much the product of organic growth as the various stages in the elaboration and perfection of prehension."

As an example to support his statement, he discusses the reactions of infants of different ages to confinement in a small enclosed pen.

"At ten weeks the child may accept the situation with complete complaisance; at twenty weeks he may betray a mild intolerance; a dissatisfaction, persistent head turning and social seeking, which we may safely characterize as mild apprehension; at thirty weeks his intolerance to the same situation may be so vigorously expressed by crying that we may describe the reaction as fear or flight."

In studies of this type, it is, of course, necessary to control the possibility of the direct or indirect effect of learning. One method by which such a control can be approximated is through the use of identical twins in matched pairs, as Gesell and his co-workers have demonstrated in a series of recent studies.

A comparative study by H. E. Jones (34) of the galvanic skin reflex in infants and in older children stresses another aspect of emotional differentiation. He writes:

"The fact that the galvanic skin reflex in infants is smaller and less easily aroused than in older children, can no doubt be explained in terms of the relationship between overt and visceral expression. If this relationship were always positive, our instrumental records would show an increase in visceral activity accompanying the more external signs of disturbance. Insofar as the galvanometer, however, may be taken as indicating visceral changes, our evidence points in another direction. Children who are the most ready to cry, are frequently the least reactive on the galvanometer; in such subjects, when galvanic skin reflexes do occur, they may be diminished or eliminated by an intensification of the stimuli, with resulting crying or bodily movement. The quick transition in emotional tone, so often exhibited in young children, is probably a further indication of the 'surface' character of their emotions, and of a lack of persisting visceral reinforcement. In older children the increase of inhibition and of apparent emotional control may imply (with reference to certain stimuli) merely a shift from outer to inner patterns of response. When a direct outward release is blocked, the condition of the organism appears to be favorable to a heightened visceral discharge, one expression of which is provided by the galvanic reflex. Thus the characteristic features of 'infantile' emotional behavior may be related to the stage of development of those mechanisms which are concerned in determining the proportions of somatic and of visceral discharge."

Peiper (59) has advanced the opinion that the greater galvanic responsiveness of older children is due to neural maturation, either central or in the efferent thoracico-lumbar pathway. He was, however, in error in stating that the galvanic skin reflex cannot be elicited in infancy.

Goodenough (23) presents evidence for maturation from an experiment in which sixty-eight university students matched photographs of a ten-months-old infant with description of the situations in which the photographs were taken. There were eight photographs and twelve descriptions; it was found that "photographs and situations were matched

correctly in 47.4 per cent of the judgments, or 5.7 times the percentage of successes to be expected by chance." Goodenough concludes that "the findings suggest that however greatly the overt expression of emotional states may be inhibited, modified, or intentionally assumed in the social relationships of adult life, the language of expression is nevertheless built upon a core of native reaction-patterns which appear at so early an age that they can hardly be ascribed to training." The possibility of training, however, cannot be satisfactorily eliminated, except with newborn subjects (as in Sherman's experiment) or with subjects for whom some sort of experimental control is maintained during development.

The Rôle of Learning. Because training and practice are more subject to laboratory proof, the investigations on the experimental modification of emotional responses have for the most part tended to emphasize the function of learning, as contrasted with maturation, in altering emotional behavior. The leading studies of this nature which have thus far been conducted have made use of the conditioned-response technique: The emotional response appropriate to an unconditioned or other primary stimulus is shifted to a conditioned stimulus through a temporal association of the two stimuli. Watson's (78) report on the now celebrated "case of Albert" may be cited as the first systematic investigation of emotional conditioning. Albert, the robust and phlegmatic child of a wet-nurse, had been made the subject of a long series of observations in an institutional environment. He had shown fear reactions to only two stimuli (loud sounds and loss of support). Towards a variety of small, furry animals, such as rabbits, dogs, and white rats, and to larger animals at the zoo, he had displayed merely a lively and inquisitive interest. At the beginning of the experiment Albert was taken to the laboratory, where a white rat was presented to him. He immediately reached toward it in an exploratory fashion. As his hand touched the animal's fur, a steel bar was struck loudly, causing a sharp withdrawal reaction. After an interval Albert's curiosity reasserted itself and he again put out his hand toward the rat. Again the disturbing sound, and the still more startled withdrawal. After seven such experiences, Albert's behavior toward the rat was markedly changed. The mere sight of the rat was enough to produce the shrinking and avoiding response of fear.[*] This was interpreted as a stimulus substitution of the same order as that shown in the conditioned secretory or conditioned defense reactions demonstrated by Pavlov in dogs.

A conditioning process is implied in an experiment by Moss (56), who associated the sound of a telegraph snapper with the taste of vinegar, in a two-year-old subject. Moss points out that the conditioned reaction did not appear invariably at first, that it was initially associated with general aspects of the situation (including the blindfold, and the preliminary administration of water), and that with repeated joint stimulations the sound, or sight, of the snapper became differentiated as the specific conditioned stimulus for negative reactions.

H. E. Jones (36) describes the establishment and later course of a conditioned emotional response in a child fifteen months of age; his report is useful as illustrating, in a single experiment, many of the phenomena commonly found in studies of conditioned reflexes in animals. In this case a mild electrotactual stimulus was associated with the ringing of an electric bell. The child's original reaction to the bell could be described as "mild interest," while to the tactual stimulus a moderate but well-defined startle reaction occurred. After four associations of the bell with the unconditioned tactual stimulus, the startle reaction appeared to the bell alone. During the subsequent course of the experiment, other phenomena characteristic of conditioning experiments were demonstrated: irradiation of excitation, discrimination, temporary external inhibition, experimental extinction of the response, and spontaneous recovery after a period of non-stimulation.

Herring (29) and Gauger (21) have repeated some of the experiments of Watson and of Moss, with special attention to the technique of observation; through the use of simultaneous ratings by two or three observers, an attempt was made to measure behavior changes in quantitative rather than in descriptive qualitative terms. Herring considers that he is able to give evidence of conditioning, but he offers no general interpretation of his findings.

For a group of twenty nursery-school children, Gauger gives the results of associating the taste of chocolate with a series of disagreeable tastes, the negative stimulus being administered one minute prior to the positive stimulus. While the negative reactions to salt and vinegar diminished during the course of several months of experimentation, it is not clear that this was due to association with the chocolate, rather than directly to negative adaptation. Gauger concludes that the evidence is insufficient to identify the type of learning involved, and states that the "type of stimulus-response method used in this study is not recommended for future studies."

Employing the galvanometric method, H. E. Jones (35) has studied conditioned emotional reactions in infants and in nursery-school children. In the case of one infant, he has reported a series of experiments extending from her seventh to her ninth month, and dealing with the problem of the retention of conditioned reactions. It was found that conditioning could be obtained in as few as six trials, associating a sound or a dim light (previously ineffective in producing a galvanic skin reflex) with an effective unconditioned stimulus. Extinctive inhibition[1] of the conditioned response was readily obtained by giving the conditioned stimulus without reinforcement. This was usually followed by recovery of the conditioned

[1]The adoption of Pavlov's terminology need not imply the acceptance of his theories of the neural basis of conditioning and of inhibition. Lashley (50, p. 552) has criticized the concept of "extinctive inhibition" on the ground that the process of experimental extinction does not involve the suppression of one activity by another and hence cannot be an instance of inhibition in the more common use of the term.

reflex after twenty-four hours or less, but, when this inhibition was developed daily, the recovery tended to be incomplete unless a longer period was allowed without repetition. Protracted extinctive stimulation of the conditioned response was shown to produce some degree of inhibition of the unconditioned stimulus, and was also a very potent factor in promoting the sudden onset of sleep—a finding similar to that frequently reported from Pavlov's laboratory. In establishing a conditioned response it was found that reinforcement could be overdone; frequently repeated or massed associations appeared to lead to a diminution in the responses both to the conditioned and the unconditioned stimuli, with full recovery on the following day. With distributed associations, it was found that a "masked conditioning" could be established, the conditioned response not being apparent until retests (without reinforcement) were given on a later occasion. The survival of a conditioned response, in spite of very frequent experimental extinction, was demonstrated over a seven-weeks period without reinforcement.

In studying conditioning, the usefulness of the galvanometric method lies partly in the possibility of reducing the intensity of the emotional stimuli, and partly in obtaining an objective record of autonomic reactions, which in the case of children are not readily accessible to measurement by other means. As will be shown in a later section, the relationship between overt and galvanic reaction is slight. In the experiment cited above, it proved to be possible to set up a very definite galvanic conditioned response, with stimuli of such low intensity that the child's overt behavior suggested an apparent complete indifference to the conditioning stimulus. However, at some stage in the procedure overt signs usually appeared. For example, in conditioning to a dim light, when the galvanic deflection to the light had risen from 0 to 15 millimeters, a summary reads:

> "The overt reaction to the light had also changed. When overt responses were recorded, these were originally in the form of 'reached for light'—'smiled'—'chuckled'—Now they were likely to read, 'Scolded'—'spit towards it'—'made a coughing sound.'"

In the terminal stages of extinctive inhibition, galvanic responses would still persist after all overt signs of negative reaction had vanished. What this indicates concerning the persistence of "emotion" may be questioned by those who prefer to define emotion either in subjective terms or in terms of external expression. It is significant, however, that the persistence of the galvanic skin reflex apparently gives some indication of the readiness with which an overt emotional response can be re-established (i.e., an overt response of the type commonly accepted as denoting emotional disturbance).

With reference to more general problems of emotional development, the work on conditioning has received varying interpretations. Watson's (76, pp. 202-215) views on this matter are well known, and are nowhere more forcibly expressed than in the following statement:

> "This proof of the conditioned origin of a fear response puts us on natural science grounds in our study of emotional behavior. It yields an explanatory principle which will account for the enormous complexity in the emotional behavior of adults."

The vitality of the theory of conditioning in contemporary psychology is illustrated in a recent discussion by Guthrie (26), who presents an able survey of the leading problems in this field. Criticisms of the conditioned response, from the standpoint of Gestalt, of "purposive learning," or of mass-action or neural-equilibrium theories are frequently encountered in the literature. Those who question the wholesale interpretation of emotional modifications in terms of the conditioned reflex point out an obvious discrepancy. Whereas the conditioned reflex is extremely unstable, emotional responses are often acquired as the result of one experience and are pertinacious even in the absence of reinforcement. These idiosyncrasies in emotional conditioning have usually been attributed to the use of extremely potent unconditioned stimuli, involving emotional trauma. It has been shown that, when mild emotional stimulation is used (35), repeated associations are necessary to secure the response, the number being comparable to that required in conditioned-reflex experiments with children involving motor responses (Krasnogorski, Mateer). Guthrie suggests that the strength or lasting quality of a conditioned stimulus may depend upon the number of conditioners involved rather than an increased strength (through repetition) of the individual conditioners. He writes:

> "It is entirely possible that if Pavlov could have controlled all stimuli instead of a very few, conditioning would be definitely established with one trial instead of fifty or more."

It is thus suggested that the complete conditioning which results from one emotional shock may be due to the effect of associating a large number of intra-organic stimuli with the unconditioned stimulus.

Since practically all of the experiments on the conditioning of children's emotions have involved the use of avoidance, rather than acceptance reactions, it is possible that differences in results are due, at least in part, to some special functioning of the avoidance or defense mechanism. Hull has considered "the dilemma of the defense reaction" and offers the concept of "organic compromise" to explain the steadfastness of the conditioned defense response. According to this formulation, experimental extinction would function in inverse proportion to the strength of the unconditioned, in this case, injurious stimulus. That mildly noxious stimuli do become ineffective unless reinforced has been shown in the experiments cited above. Probably further experimental evidence on this point, involving the use of stronger stimulations, should be left to the animal experimenters.

Another point to be considered is that the substitute stimuli used in conditioning children's emotions are not always merely incidental. With-

out subscribing to a belief in the instinctive fear of animals, we can admit that by presenting animals in conditioning experiments we have chosen stimuli of more than incidental attention value to the children.

Valentine (74) reports a case in which the sound of a whistle, as an unconditioned stimulus, was associated first with a pair of opera glasses and later with the sight of a caterpillar. The child was quite readily conditioned to the caterpillar but not to the glasses. The value of this report lies chiefly in the suggestion that all substitute stimuli are not of equal indifference to the subject. Just what the relation is between the quality of the stimulus and its substitution potentiality is a problem for further research. L. K. Frank (20) has given a valuable discussion of possible lines of investigation in this field.

There is no lack of evidence from daily life of phenomena which have at least a superficial resemblance to conditioning. Many instances of casually observed "conditioned phobias," and the like, have found their way into psychological literature. One of the most striking of these is a case, cited by Anderson (2), of a child whose conditioned fear to a small black terrier was revived after eleven months by an encounter with a similar animal. The encounter was apparently adequately tolerated by the child, but was followed by a terrifying dream about the dog. The dream, in Anderson's interpretation, functioned as a reconditioning process; and this reinforcement was so powerful that a generalized fear of all dogs persisted for a period of years.

The process of generalization (irradiation) has frequently been mentioned in the accounts of animal experiments. In emotional conditioning, also, this phenomenon has been noted by a number of writers.

Watson describes this aspect of conditioning in the case of Albert. After the child had become conditioned to withdraw from the rat he exhibited the same fear response when in the presence of a rabbit, a dog, a sealskin coat, cotton wool, and hair. Watson (79) comments:

> "Our notes . . . give a convincing proof of spread or transfer. . . . When conditioned emotional responses are first set up, a wide range of stimuli (in this case all hairy objects) physically similar will at first call out a response, and so far as we know will continue to call it out unless experimental steps (or a very fortunate series of environmental settings) are taken to bring the undifferentiated conditioned response up to the differentiated stage."

If the process of conditioning is responsible for attaching a devastating fear reaction to a harmless object, can it also be relied upon to substitute a desirable reaction for the fear response?

M. C. Jones (42), following Watson's method, was able to eliminate a child's fears by associating a pleasure stimulus with the fear stimulus. At the beginning of the conditioning experiment, the child, Peter, was afraid of furry animals such as a white rat and a rabbit, of feathers, of fur coats and other furry objects. This fear was partially allayed in the course of several months during which the child gradually adopted the

behavior of other children who displayed a confident and fearless attitude toward the rabbit. An accidental encounter with a dog rewakened the fear, however, and retraining was instituted by a conditioning method. The child was presented with two stimuli, one which called out a pleasure response, the other which called out a fear response. By controlling the presentation of the two stimuli, the pleasant one (food or candy) was always stronger than the negative one (a rabbit). Therefore the child's positive responses prevailed in the situation and finally became attached to the rabbit. Toward the end of the laboratory sessions, other fear objects, such as a white rat, worms, feathers, and various furry objects, were again introduced. These also were accepted with equanimity. The experimenter concludes:

> "By 'unconditioning' (to the rabbit), Peter has apparently been helped to overcome many superfluous fears, some completely, some to a less degree. His tolerance for strange animals and unfamiliar situations has apparently increased."

This experiment suggests the desirability of relating scientific inquiry in child study to the welfare of the individuals who serve as subjects. There are many phases of conditioning which, theoretically, could be studied by the use of positive rather than negative stimuli. Practically, the observation and measurement of positive responses is much more difficult. It is to be hoped that improved techniques and better facilities for studying children will serve both the interests of science and those of the child who functions as subject.

The case of Peter further suggests the practical applications of the conditioning technique in the home and the clinic as well as in the laboratory. It is understood, of course, that the treatment of a specific emotional disturbance, such as fear, is often a minor consideration in handling personality difficulties. In some children one fear is removed only to give place, in the course of time, to another. In such cases underlying causes must be probed and adjusted.

In discussing the research on unlearned emotional equipment, it was pointed out that the emphasis had swung from purely physical descriptions of stimuli to more dynamic formulations in terms of the reactions of the individual organism. A similar change of emphasis may be expected in future work on the conditioning of children's emotions. Children become conditioned to new stimuli in the strange environment of the laboratory, while apparently equivalent stimulus-response patterns presented in familiar surroundings have no effect. To interpret such results, the experimenter must take into consideration the child's adjustment to the total situation—which involves not only the specific stimulus but a variety of environmental factors. The results are affected by the freshness of the subject, by his reaction to the presence of strangers or to being left alone, and by a thousand and one other habitual modes of response which go to make up the individual personality. Some of these variables are not

subject to controlled experimentation. However, a review of the literature suggests a number of problems, the solution of which would add both to our scientific knowledge and to our practical procedures in handling young children.

Clinicians in dealing with problem children have been in a strategic position to discover the general situational factors most charged with emotional significance. Blanchard (5) has pointed out that psychiatric studies of the emotions of children

> "suggest that the parent-child situation may have influence in the development of emotional reactions or in prolonging or intensifying conditioned emotional responses. Clinical data in psychiatry indicate that fears are frequently utilized to secure attention (by the rejected child). We don't know yet whether fears can grow out of the parent-child relationship without any process of conditioning or whether fearfulness originally conditioned continues (for purposes of gaining satisfaction), long after the fear has died out."

Whether or not the fundamental processes of emotional genesis are understood, it is clear that development depends upon the child's increasing capacity to select and react to a wider variety and greater complexity of stimuli, and to coordinate, integrate, and intelligently adapt his responses.

Studies of Specific Emotions

The nursery has offered an appropriate laboratory for studying the earliest emotional responses and the first significant stimuli. However, it is probably in the preschool years that the most vivid portrayals of emotional life can be obtained. By two years of age, the child has acquired easily recognizable modes of expressing the emotions and has not yet been overtaken by the inhibitions which make it so difficult to observe emotional processes in school children and adolescents. In studying the child's selectivity in regard to stimuli, and the modifiability of responses, the two-to-six-year group has been used extensively. Nursery schools have frequently furnished a laboratory setting, and for the most part "normal" children have been the subjects.

On the basis of observations made in a nursery school, Bridges has listed seven different emotions which are present in two-year-olds. Three of these, excitement, distress, and delight, are the relatively undifferentiated emotions of infancy which continue to function along with the more specific emotions of fear, anger, jealousy, joy, and affection. As the result of more recent observations in a foundling hospital, Bridges (9) has added "disgust" and "elation" to the list of specific emotions for two-year-olds; "affection" she has subdivided into "affection for adults" and "affection for children."

Some of the specific emotions listed by Bridges have been studied in detail by other writers. Their results are briefly reviewed here, with

special emphasis, first, upon the situational factors which are effective in arousing emotions at different ages; and, secondly, upon the emotional responses appropriate to the particular stage of development.

Situational Aspects of Emotional Behavior

Anger Stimuli. The stimulus conditions calling forth anger in young children have been described by Bridges (8) as follows:

> "Anger is prompted by a situation which instead of being a sudden call to action is a more or less sudden stoppage or interference with action. The character of suddenness is not such an essential part of the picture in anger as in fear, though in both cases there is a call for quick readjustment. Interference with activity, especially activity motivated by instinctive or universally common drives, is the essential criterion of an anger-producing situation."

This description is borne out by Goodenough's (25) tabulation of outbursts of anger in connection with activities involving dressing and undressing and similar personal care, going to the toilet, and various aspects of going to bed. M. C. Jones (76, pp. 140-141) also reports, among the situations calling out cries of anger, having property taken away, having the nose wiped or face washed, having to sit on the toilet, working at something which proves difficult.

The relationship between more general environmental factors and anger outbursts is summarized in Goodenough's study as follows:

> "Any temporary condition of imperfect health, such as a slight cold, tends to increase the frequency of outbursts over that reported on days when health is said to be normal. Outbursts are also more frequent when the child is constipated than when his bowels are in a normal condition. Among children in the process of training for nocturnal bladder control outbursts are almost twice as frequent on days following nights when the bed was wet as on days following dry nights."

Since children have been known to withhold feces and wet themselves for emotional causes, it is not surprising to find enuresis or constipation associated with temper tantrums as an expression of some underlying disturbance.

Fear Stimuli. Most of the situational factors responsible for evoking fear have been reviewed above in the discussion of the rôle of maturation. We can add to these directly stimulating situational factors the underlying conditions which are potential for all emotional behavior. Hagman (27) reports a tendency for children to have fears which correspond closely to the fears of their mothers. Such physiological factors as fatigue and ill health, and environmental factors such as those involved in family and social relationships, may lower thresholds, accentuate, and prolong emotional responses. It is probably due to some of the later-mentioned considerations that a child who is treated for one specific fear

may, in losing that fear, promptly develop another one—sometimes even more baffling than the first.

Situations Causing Jealousy. Jealousy may be considered here as a type of behavior still further removed from the category of early undifferentiated "distress." Watson (76) has pointed out that the situation which produces jealousy is always a social one and that it involves persons who call out conditioned love responses. Bridges considers jealousy to be the kind of anger which is aroused by thwarted self-expression and by the withdrawal or transfer of attention anticipated or previously received.

Pearson (58) believes that jealousy of siblings results from the fact that children look upon each other as rivals for the affection of the parents, especially the parent of the opposite sex. It is also a common conception among psychoanalysts that a child's jealousy of the parent of the same sex is frequently transferred to a sibling of the same sex, because it can thus find expression with less likelihood of punishment. Psychoanalysts have considered jealousy to play a more important rôle in girls and women than in boys and men, owing to reinforcement from castration complexes.

The arrival of a new baby brother or sister is considered a classical situation for the arousal of jealousy. That this is by no means universal is illustrated by the experiment reported by Watson (76) involving a child of two and a half and his new baby brother just home from the hospital.

Though the babe in arms may not provoke immediate jealousy in an older sibling, it is rather likely that, sometime during their home life, jealousy will motivate the behavior of siblings. When the baby becomes old enough to walk, to have his chair at the family dinner table, to make his presence felt at school and on the playground, he is more apt to stimulate jealousy in an older sibling than is the newborn, helpless infant.

Foster's (19) clinical study of fifty jealous and one hundred non-jealous children between the ages of one and six would tend to corroborate Freud's belief that girls are more likely to be jealous than boys. She found that the jealous child is more often a girl between three and four, and frequently the oldest child; she is subject to mild neurotic fears and shows a tendency toward markedly extroverted behavior.

Ross (65) analyzed clinic data in comparing jealous with non-jealous children and came to the conclusion that jealousy occurred a little more frequently among girls than among boys, tends to appear in early childhood, and is more frequent in bright than in dull children.

Sewall (67) and Smalley (70) reported no sex differences in regard to jealousy in their clinic cases, though Smalley did find a larger proportion of jealousy among girl-girl combinations. Sewall reported that this type of behavior was most marked between the ages of one and a half and two and a half. Since all of these studies were based on clinic data

collected for a variety of purposes, rather than direct observations of jealous behavior, the results are suggestive but far from conclusive.

Situations Which Produce Negativism. It is interesting to note that at about the time we reach this degree of complexity in emotional processes the stimuli become so varied and the responses so individual that we cease observing emotions as such. Instead, we speak of behavior which has emotional components. However, some types of behavior are more strongly tinged with emotion than others; negativism or obstinacy may serve as an example. This is usually included in a discussion of social behavior, but should at least be mentioned in a chapter on emotional development. The emotional component is traceable to anger, but is aroused by a very specialized social situation. It may also involve elements of fear, when it is the emotional response to a situation which is too difficult for the child or which centers attention upon the child.

Negativism in young children has been studied frequently in connection with the psychological test situation. Levy and Tulchin (51) report resistant behavior during mental tests as early as six months. This type of negativism they found to be at its height in girls at eighteen months and in boys at thirty months. Children's resistance in test situations has also been studied by Goodenough (23), Nelson (57), Rust (66), and by Reynolds (61) in other laboratory situations as well. In these investigations negativism was found to be more prevalent among the younger, less intelligent children of lower social status.

Bühler and Hetzer reported a negative phase in the pre-adolescent, which Hurlock and Sender (32) found to be related to inferior surroundings. Klein (48) expresses the belief that an underlying anxiety in children is apt to be intensified and to express itself in obstinate and violent resistances in puberty.

Emotional Response Patterns

The formation of definite response patterns to emotional situations is also a part of the growing-up process. These responses have been described for different age levels by a number of writers.

Sherman (68) describes the early emotional responses as follows:

> "Although these responses are indefinite at first, very early two types of adjustive reaction can be noted: first that of rejecting a stimulus, and second, that of accepting a stimulus."

As has been pointed out before, further differentiation occurs early in infancy, though emotions involving very similar components are occasionally indistinguishable.

Anger Responses. Anger may from present evidence be said to be differentiated early in life from some more general undifferentiated avoidance reaction. Bridges describes the expression of anger as follows:

> "Anger is usually accompanied by outbursts of impulsive activity,

> such as kicking, stamping or slashing of the arms. It is often expressed in prolonged holding of the breath—. Mild anger or annoyance is characterized by aggressive movements . . . protests and appeals . . . the lips are protruded in a pouting expression or dropped at the corners in a sulk—the forehead may be puckered in a frown and the jaw thrust forward as a set for action."

Goodenough lists the following "specific aspects of behavior during anger": kicking, stamping, jumping up and down, throwing self on floor, holding the breath, stiffening the body, making the body limp, refusing to budge, pulling away or struggling, running for help, turning away bodily, or turning the head, closing the mouth tightly (from forced feeding), refusing to swallow, pouting, frowning, throwing objects, reaching, grabbing, biting, crying, screaming. Later come verbal refusals, threats, calling names, arguing, insisting. Goodenough's study of anger is based on daily records kept by a group of mothers of infants and young children. These mothers recorded every instance of angry behavior, as well as general contributing factors, over a period of from one to four months.

It is apparent that overt manifestations change with age. Bridges has pointed out that development "consists in the substitution of more and more socially acceptable ways of removing an interfering nuisance and in the developing of a greater variety of approved interests and action patterns to supplant the activity thwarted."

Goodenough (25) expresses the change in this way:

> "With advancing age behavior during anger becomes more overtly directed toward a given end. At the same time the primitive bodily responses of the infant and young child gradually become replaced by substitute reactions of a somewhat less violent and more symbolic character. As age advances, the proportion of outbursts in which the behavior consists only or chiefly of simple displays of undirected energy decreases, while the frequency of retaliative behavior increases. There are more evidences of persisting generalized reactions toward a single person and more attempts to retaliate by means of indirect attacks designed to hurt the feelings rather than to injure the body of the offender. The percentage of observable after reactions, particularly resentfulness and sulkiness, increases steadily with advancing age."

Fear Responses. In the case of fear, Bridges has summarized the overt changes observable in the preschool age as follows:

> "Emotional development in regard to fear consists in the substitution of more and more adequate specific responses to startling or terrifying situations for the earlier exhibited panic. It comes invariably with greater knowledge and understanding of things in general; and it comes with the development of a greater variety of responses, of co-ordination and control of movements. After screaming, crying and rigidity as modes of response, children first

> adopt running away and then partial withdrawal from fearful situations. They refuse to be enticed toward the cause of fear, they hold aloof or avoid the whole situation and pay attention to something else. Exclamations, and laughter, are often substituted for cries at a sudden noise or fall. Thus gradually more or less indifference and quick adjustment supersede panic, hesitance and inappropriate responses."

The gradual conquest of fear, as it has been described above, is probably more hygienic than sudden repression. We have evidence from galvanometric studies that there are circumstances in which the external manifestations of fear may be inhibited at the cost of an increase in internal disturbance (see page 294).

Jealous Responses. Jealousy includes such varied responses that unless the situation is known the behavior cannot be identified. Sewall's listing of jealous children showed nothing identifying about the responses except that they were directed against the sibling, or were manifested subsequent to the sibling's birth. In the latter case, the responses often represented a regression to a more infantile mode of behavior. The child refused to dress or to feed himself, or developed enuresis apparently as a protest or in order to gain more of the mother's attention.

Negative Responses. A similar variety of behavior is shown in negative responses. The child may attack, withdraw, or regress, and it is difficult, when the situation is not defined, to recognize the emotional drive behind such behavior. Bühler (32, p. 326) has described the preadolescent girl in a negative mood as showing "obstinacy, ferocity, waywardness, indolence, irritability, melancholia, hatred of self and society."

The Overt and Internal Expression of the Emotions

In the study of emotional development, attempts have been made to investigate specific phases of emotional expression, including crying, laughter, muscular tensions, and internal changes associated with alterations in autonomic balance.

Crying. Bühler's (10) study of the first year of life includes a description of the development of crying. She found that in the early months crying is usually connected with movement, in a nondescript pattern which the Ohio State investigations (60) have termed "mass activity." By six months, crying may occur when the child is lying quiet and overt movements are inhibited. Crying with tears begins only after the first month. Bühler lists the causes of crying as pain, strong sensory stimuli, uncomfortable or abrupt changes in posture, strong disturbances during sleep, fatigue, hunger, frustration (which includes restriction of movement), failure to hold a certain posture, loss of a toy, etc. Social factors in crying begin to be important at three to four months, as in the cessation of social contacts. At a slightly greater age, the approach of a stranger may induce crying. A social factor may also operate as early as two months, in the case of imitating the crying of another child.

Bayley (3), in a study previously cited, indicates the manner in which crying behavior changes in the first year:

> "In the earlier months crying resulted mostly from internal organic causes, bodily pain and distress; later the external environment became an increasingly potent factor. Such factors as fatigue at the end of the test, and colic pain, became relatively less important than fear of the strange situation and dislike of unusual handling."

Jones (76, p. 140-141) tabulated the crying responses of nine temporarily institutionalized children during their waking hours for two periods of seven days each. The children ranged in age from sixteen months to three years. A score of the specific situations could be classified as interference with activity (having to sit on the toilet, having the face washed, having the nose wiped). Other cries were produced by frightening situations, such as standing in high places, being left alone in a room. Still others were due to anger or grief at frustrations in social situations (when the adult left the child alone or when other children refused to play with him). The largest number of crying episodes came at the end of the morning when the children were tired and hungry. When the rest periods were adjusted to the needs of the children, the total amount of crying was considerably lessened.

Bridges found indications that crying with tears resulted from mixed emotions: anger or fear diluted by relief, or joy and excitement accompanied by some disturbing fear response. "The cry of real pain or fright or intense anger without any alleviating circumstances in sight is a dry cry. A frightened scream or shriek may turn to tears as soon as help comes in sight or the trouble becomes minimized." Crying seldom occurs after the first few weeks in nursery school and rarely after the children are three years of age, when verbalization is substituted. Crying in nursery school Bridges attributes chiefly to distress and discomfort. The crying of newly enrolled children is due to the lost sense of security. The "newness" of situations at school may start an outbreak of tears—the locker where the children must leave coats and hats and sometimes treasured toys from home, the new toilet, unlike the one at home around which routine habits and associations are built, the new bed at nap-time. When crying is unduly frequent or prolonged past the three-year period, the causes may be traced to oversolicitude of parents, a heightened sensibility to sensory shocks, or the lack of intellectual ability to benefit readily by experience and thus to develop emotionally.

These studies of crying illustrate the development of emotional behavior with changes in the variety and complexity of situations to which the child responds, and with alteration and integration of response in the direction of adult standards of conduct.

Laughter. While crying lends itself readily to study in young children, it has the disadvantage of being an undesirable form of response which

has to be dispensed with, in public at least, rather early in life. Laughter, on the other hand, though an allowable and approved form of emotional expression which may persist throughout life, attaches itself to such elusive and varied situations that it frequently defies analysis.

Smiling and laughter in infancy have been discussed by Bühler (10), Jones (43), and Washburn (75), on the basis of data from observational studies. All agree that smiling (other than a merely reflex smile as from intra-organic stimuli) occurs for the first time in the second month of life, and characteristically in response to a "social situation"—usually to the smile of the mother.

Washburn's study involved periodic observations of the same children in a controlled situation during the first year of life. Laughter, although appearing later than smiling, had the appearance of a more primitive stereotyped response. An increase in the variety of situations causing laughter was found to be a characteristic feature of early development.

Jones reported laughter situations for the same institution group of preschool children for whom crying records were taken. Eighty-five specific situations were listed, of which the seven most frequent were:

1. Being played with (physical contacts in dressing, tickling, etc.)
2. Running, chasing, romping with other children
3. Playing with toys (a ball was particularly effective)
4. Teasing other children
5. Watching other children at play
6. Making attempts which resulted in adjustment (e.g., getting parts of toys or apparatus to fit together, or to work)
7. Making sounds, more or less musical, at the piano, with a mouth organ, singing, pounding, etc.

The three most effective causes of laughter were: (*a*) those related to a feeling of well-being (running, romping, chasing); (*b*) exciting physical contacts (tickling, playful handling); and (*c*) situations which provided opportunity for self-assertion (teasing other children, overcoming difficulties, making noises or musical sounds).

Bridges believes that laughter, like crying with tears, is the result of mixed emotions—it "is a sudden release of pent-up energy, of tension due to previously unsatisfied or only partially satisfied desires." Sudden self-assertion in a social situation where such an impulse must often be held in check is an example of this behavior, as is also sudden winning of approval. Laughter with delight in active movement, and imitative laughter, appear first in nursery school. By the age of three or four, "as they develop a sense of the fitness of things, they laugh at their own or others' mistakes, at incongruities and absurdities, or unusual events. Occasionally but not often at this age children laugh spontaneously at jokes in stories."

Up to the present time, the most complete experimental approach to laughter in preschool children from three to six has been reported by Justin (44). From a thorough review of the literature on the subject

she devised fifty-four individual situations to provoke laughter. These fell into six categories: (*a*) surprise-defeated expectation, (*b*) superiority-degradation, (*c*) incongruity and contrast, (*d*) social smile as a stimulus, (*e*) relief from strain, (*f*) play. The method of presentation of each stimulus was well controlled, as was the method of recording responses. Two observers besides the experimenter recorded smiling and laughter, bodily activity, and verbalizations. Justin found that by the age of three some stimuli from each of the six categories produced laughter. However, she was impressed with the marked increase in the number of situations which provoke laughter in the immediately succeeding years. And this extension of the field is not by a sudden development of one line of response but by a gradual extension of reactions to all the types of stimuli considered. Incongruities, superiority, and play situations become more potent as age increases. Likewise, pictorial presentations, such as a boy getting spanked, were very funny to six-year-olds, but not to younger children, while tickling brought a considerable frequency of response at three but little at six years. The enlargement of the field of laughter-provoking objects is seemingly an outcome of the total process of mental growth, rather than of any single maturational sequence.

Enders (17) studied laughter in nursery-school children by a combination of experimental and observational methods. She found that in two-, three-, and four-year-olds, alike, sound and motion or a combination of these were very effective stimuli. All of the children laughed most frequently in social situations with other children, and seldom when alone or with adults. Older children began to find word-play humorous but there was no relationship between frequency of laughter and intelligence.

Kenderdine (45), who recorded laughter episodes among nursery-school children, is in agreement with Enders in placing situations involving motion first in provocativeness. She also found the presence of other children to be a potent factor in exciting laughter. Unlike Enders, she reports that children who are brighter laugh more frequently.

A study of laughing, crying, and other vocal and facial expressions of emotion has been made by Robinson (63), who recorded, for fifty nursery-school children, a series of twenty four-minute short sample observations. A reliability of .95 was obtained for "frequency of emotional reaction," and very slightly smaller reliabilities for other emotional measures which involved a weighting of intensity factors and of pleasure-displeasure reactions. The correlations were computed on the basis of odd-even fifteen-minute records, and indicate that this method of "quantified observation" is adequate for the measurement of the specified aspects of emotional behavior. It must not be thought, however, that a similar degree of certainty applies to the prediction of emotional behavior from one day to another. Consistency coefficients, based on correlations for odd-even days, dropped to .80 for frequency of emotional reaction, and to slightly lower values for the other emotional measures.

Two studies have made use of somewhat formal test situations, designed to elicit individual differences in various types of emotional reaction. Marston (53) has standardized situations for the observation of (*a*) cautious reactions, (*b*) reactions to a novel environment, (*c*) self-assertion in response to denial, (*d*) compliance, and (*e*) resistance to a stranger. Robinson (63) has made use of a series of frustration and startle situations. In each case, the experimental results were checked against ratings. The principal outcome of these studies appears to lie in the evidence for specific emotional reaction, as opposed to the concept of a "general" emotionality.

In applying the genetic method to the study of emotional processes, our work with young children has been rather largely restricted to the recording of overt behavior, or to inferences from clinical data. A recent review (39) lists a number of instrumental procedures which have been employed with young children (Canestrini, kymograph curves of respiration and fontanelle pulse; Binet and Courtier, and Eng, plethysmograph records; Denisova and Figurin, respiratory variations studied by means of the Lehman pneumograph; Johnson, and Duffy, changes in muscle tension). Physiological methods of investigation involve, for the most part, somewhat clumsy apparatus and artificial laboratory conditions. In this connection the galvanometer has proved to have some advantages, since all of the apparatus can be housed in a separate room, with the exception of two small electrodes attached to the child. In the case of young children, these electrodes are bandaged to the foot; the child lies on a couch or sits at a play table, without restriction of manual activities. In interpreting galvanic records, it must be remembered that the galvanometer is directly concerned with only a limited segment of autonomic reaction, and that it should not be expected to give results representative of total emotional response.

From a study of thirty nursery-school children, Wechsler, Crabbs, and Freeman (80) concluded that "the psychogalvanic experiment reveals itself as an available and reliable method for the investigation of affective responses of preschool children to various types of stimuli." Individual differences in galvanic response were computed in terms of the subject's median galvanic response to a series of provocative stimuli. The retest correlation, for nineteen children, was .73; for several of the individual stimuli retest correlations were obtained of between .50 and .60. There were found, however, very low and generally negative correlations between median galvanic response and other measures of emotional response, including teachers' ratings of irritability, anger, and fear tendencies. A factor affecting correlations was the apparently paradoxical finding that "the children who gave the smallest galvanic responses were either those rated unemotional or highly emotional." It was inferred that some of the "highly emotional children" were so markedly stimulated

by being brought into the experimental situation that the specific stimuli had little further effect!

H. E. Jones (37) has obtained similar results with preschool children, but has offered a different theoretical formulation, in terms of the pattern of overt and implicit responses. This investigation was based on simultaneous galvanometric and observational data for eighty subjects, each of whom was tested on two different occasions, with a standard series of stimuli. The most effective stimuli were those involving sudden sounds or movements: a brass cylinder falling from the table, a buzzer, a box which began to vibrate in the child's hand because of a concealed motor. The sight of a white rat aroused moderate emotional responses, which became more marked when the child was invited to pat the animal. A mental-test situation, a throat examination with a pharyngoscope, the use of calipers in head measurement, etc., proved to have, on the average, very little stimulation value. Three principal findings were stated: (1) In a single experiment both the galvanic reaction and the overt emotional response can be measured with adequate reliability (split-half correlation above .90). (2) The galvanometer classifies the emotional value of stimuli in much the same way as two competent observers who are watching closely for emotional symptoms (as indicated by a correlation of .80 between the average galvanic deflection for each stimulus and the average rating for each stimulus). (3) Individual children differ in the pattern of galvanic and overt response. In the majority of individuals *no correlation is found.* Although the galvanometer and the ratings agree as to the provocative value of stimuli, in the individual child the tendency is for the emotional response to be selective and specific, rather than generalized. In a few children, a definite positive correlation occurs (beyond chance), and in a few a negative correlation is apparent. These latter are similar to certain of the cases reported by Wechsler, Crabbs, and Freeman; they include, however, not merely children who give small galvanic deflections together with marked overt expression, but also children whose galvanic deflections are of large magnitude and are accompanied by restrained and inhibited overt behavior. Such individuals may be thought of as representing "extrovert" and "introvert" extremes.

With reference to the problem of family relationships in emotional traits, Jones (37) obtained preliminary results from thirty-two preschool like-sex twins. For these the retest correlation, in terms of average galvanic deflection, was .72. The twin correlation for a single test was also of the order of .70; in other words, one twin agreed with his co-twin in galvanic reaction on a certain day as well as he agreed with himself on different days. The twin correlation for the average of both tests was .88, which is comparable with that found for identical twins in measurements of intelligence and achievement.

Collman (14) has made an extensive galvanometric study of 310 children of school age, divided into superior, normal, and mentally de-

ficient groups. The mentally deficient were less reactive than the normal children, a fact which is in agreement with Morrison's (55) finding that among feebleminded a marked positive correlation exists between intelligence and the overt expression of anger and affection. Collman also found, however, that the normal children were reliably more reactive than gifted children. This is perhaps explainable in terms of a greater sophistication of the gifted group—they can more readily "see through" and prepare adjustments for an artificial laboratory situation. In comparing one hundred normal white with one hundred normal colored children in the same schools, significantly greater reactions were found among the colored children. This deserves some attention as being perhaps the first race difference study based upon an objective instrumental measurement of emotional reactions.

Finally, Collman reported a relationship between galvanic responsiveness to concrete stimuli, and emotional stability, as determined by other criteria, in the group of mental defectives. While this finding is given somewhat tentatively, it would appear to indicate that at least for experimental purposes the galvanometer may have some value in connection with clinical work.

Johnson (33) and Duffy (16) have related muscle tensions to emotional factors by measuring the contractions in the minor hand when the dominant hand was performing such a task as pressing a button in response to a light. During a part of the experiment, emotionally provocative stimuli were given. Muscle tensions from the minor hand were transmitted through a rubber ball and tube to a kymograph, upon which were also recorded the reactions of the dominant hand, and the time of appearance of the various stimuli. Ratings on excitability were obtained from nursery-school teachers for the purposes of comparison. Duffy concludes that

> "tension, as measured in the muscles of the unused hand, seems definitely correlated with excitability. The connection between the two is evidenced by the close correspondence between the ratings on excitability and the average height of tension scores; and by the tendency of specific excitative stimuli to cause a definite rise in the tension line at the moment of their introduction. . . ."

The possibility that the tension record may be affected by voluntary contractions must be considered in studies of this type.

Studies have been made which approach from other directions the relationship between physiological functions and emotional behavior. Rich (62), for example, has investigated specific aspects of body chemistry in relation to emotional characteristics. Among Rich's subjects were 134 children, rated by four clinic workers on good-naturedness, aggressiveness, and excitability. A low positive correlation was found between hydrogen-ion concentration of the saliva and the excitability ratings. This

general field of research appears to be one in which we may expect important results from further work.

Emotional Stability. The interest in the functioning of the emotions has led to a variety of attempts to study individual differences in the intensity and frequency of emotional response, in emotional inhibition, and in cyclical changes. As an approach to group studies, a testing technique has been developed which does not measure emotional expression directly, but attempts to discover individual differences in stability as indicated by the answers to symptomatic questions.

The earliest form of this test (Woodworth's Personal Data Sheet) was revised by Johnson, and later by Mathews (54) for use with school children. Mathews assembled 100 items including such questions as: "Do you usually feel well and strong?"; "do you often have the feeling of suffocating?"; "do you have queer unpleasant feelings in any part of your body?"; "are you troubled with the idea that people are watching you on the street?" Any subject is expected to make a certain number of answers deviating from the normal, but with emotionally unstable or neurotic children the incidence of deviate answers is expected to be high. In Mathews' use of the term, "stability" carries implications of "balance and duration"; while instability implies "vacillation." She tested a large group of New York City school children, some unselected, some picked by teachers as nervous and unstable, others from special groups, such as orphans and reform-school girls. For 280 boys, ages twelve to fourteen, a somewhat discouragingly low reliability coefficient was obtained (.67, split-half). Validity coefficients (correlations with teachers' ratings of emotional stability) ranged in various groups from .52 to .66.

Slawson (69) used Mathews' questionnaire in an abbreviated form of 70 items, in order to compare a group of 134 delinquent boys from three institutions with Mathews' 500 unselected boys. He found only 16 per cent of the delinquents at or below the average of the unselected group in the number of symptomatic answers. Slawson was one of the earlier workers to attempt to group items and call them "symptoms" of underlying "traits" of abnormality. Some of the symptoms he considered diagnostic of delinquency, such as those pertaining to the following:

1. Conflicts with home and parents
2. Phantasies
3. Ideas of persecution
4. Morbid states of joy and anger (the delinquents said they saw red more often, but the non-delinquents said they giggled more often)
5. Tendencies toward morbid depressions (such as "do you sometimes wish you had never been born?")
6. Delusions of guilt, inferiority, and the like ("do you often feel that you have been very wicked?")
7. Impulsive tendencies (to steal or to set fires)
8. Physical symptoms (tics, fatigue, peculiar pains)

Symptoms which did not diagnose delinquency were:

1. Sociability
2. Conflicts in school
3. Fears and phobias

Of numerous tests which have been used to compare delinquent and non-problem children, emotional questionnaires or inventories have proved to be among the most discriminatory. With a modification of the Woodworth-Mathews, Cady (11) found a group difference between "corrigible" and "incorrigible" boys in the public schools. The validity coefficient, however (correlation with a criterion based on ratings of four judges), was too low for use in individual differentiation. Loufbourow, comparing 308 problem children with the same number of control children in the public schools of Berkeley and San Francisco, found a reliable difference between the two groups in scores on a modification of the Cady questionnaire. Bi-serial r with the criterion was $.33 \pm .04$. This was raised to $.60 \pm .06$ when a committed delinqent group was substituted for the school problem group.

In a small sample of adolescent girls, Bridges (7) found that normal children had higher stability scores than delinquents, and that "adolescent instability" had its incidence at an earlier age among the delinquents. The problem of adolescent changes in emotionality is one which requires much additional work by cumulative methods; a promising lead, in this connection, is the comparison, longitudinally, of behavior data with records of physiological development. To mention one approach to this problem, Abernethy (1) has found that, while in general there is little correlation between adjustment and sexual maturing, in cases of marked physiological retardation more problems are likely to appear than among those who mature normally.

The relationship of inventory measures to intelligence has received attention from several investigators. Mathews found negative correlations with IQ, ranging from —.055 to —.59. To some extent this may be due to the ability of brighter children to discern socially "acceptable" answers. Keys and Whiteside (46), in agreement with Terman's (73) results for gifted children, have found that children of superior intelligence and school standing tend to be superior in measures of stability; as measures, they used Woodworth-Cady scores and also teachers' ratings.

Holzinger (30) has found a slightly greater resemblance of identical twins than of like-sex fraternals in the Mathews inventory. This is in agreement with the results from two other investigations which have made use of interview data from parents concerning emotional characteristics of twins (Day, 15; Jones and Wilson, 40). Such findings cannot, however, be used directly to demonstrate the rôle of heredity in determining emotional make-up, for identical twins have not only a more similar heredity, but also develop under a more similar environment than is the case with fraternals.

Chambers (13) has attempted to construct a measure of emotional maturity, using the Pressey X-O tests scored with reference to the differential performance of children of different ages. Since it has not been satisfactorily demonstrated, however, that the Pressey tests measure emotional status at any given age level (49), we cannot be sure that age differences in scores represent emotional maturity, rather than some other phase of growth.

Since 1930, a number of innovations have been attempted in the content of emotional inventories. In tests for children, Symonds (72) and Rogers (64) have been most fertile in the suggestion of new items. Inasmuch as these involve a wider range of behavior than the earlier "neurotic" or "emotional" schedules, the questionnaires are usually described as "adjustment questionnaires" or "personality tests." Symonds asks questions about school curriculum, school social life, teachers, other pupils, home, and family. As in the earlier questionnaires, the assumption is that children who find an excess number of things to complain about are unadjusted. Rogers goes to the psychiatric clinic for his questions and includes those items about which psychiatrists are most apt to be concerned—those which have to do with inferiority feelings, phantasies, and family and social adjustments.

The form of recent tests has also departed radically from the earlier inventories both in method of presentation and in scoring. The unique feature of the Rogers tests is the attempt to ask questions indirectly. For example, instead of presenting to the child a question as to whether or not he feels inferior in this or that situation, the child is asked, "If you could have three of the wishes below which ones would you choose?" If, from a list of ten answers, a child chooses to be bigger, stronger, better looking, he is given a score which is regarded as related to personal inferiority.

Numerous other inventory and test devices are available which measure, more or less reliably, and with more or less doubt as to the precise nature of the functions measured, "introversion-extroversion," "morbid attitudes," etc. Space is lacking in this chapter to discuss these and related phases of personality measurement; the reader is referred to the recent work of Symonds (71) for a description and appraisal of the principal methods of investigation in this field.

In the foregoing discussion of the development of the emotions, we have dealt with theoretical more largely than with practical aspects (see, however, Chapter 22). We have noted that, although the era of speculation concerning problems of growth has given way to a period of extremely active empirical study, our methods of investigation are still in a relatively crude state and we still have numerous controversial issues which do not yield readily to experimental attack. No one doubts, however, the significance of the leading problems in this area of inquiry and the possibilities for major achievements in the research of the next decade.

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CHAPTER 7

THE MEASUREMENT OF MENTAL GROWTH

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The literature on the general subject of mental growth and its measurement is so voluminous that it would be impossible to review it in any detail within the space limits of this chapter. Even a bibliography listing the most important contributions of the last ten years would occupy many pages. It is doubtful whether any other single topic in human psychology has excited more widespread interest or has been made the subject of so many and extensive investigations as has the topic of mental growth and its measurement (33). From the outset this interest has been particularly keen in America, but in European countries it is also strong. In 1922 when the interest in testing was at its height, approximately 5 per cent of all publications listed in the *Psychological Index* dealt with that topic. Although the number of publications primarily concerned with mental testing has fallen to about 2 per cent since that date, the section on mental tests still forms an important classification in both the *Psychological Index* and the *Psychological Abstracts*. It should be noted further that a large percentage of the articles classified in other sections of these journals have to do with experiments in which mental tests were used as one of the tools of investigation. As the place of mental tests in psychological practice has become more firmly established, their use is more often taken for granted. The more widely an instrument is used, the less attention it is likely to attract.

An extremely competent description of the early history of mental testing and the points of view which influenced the development of the early tests is to be found in *Early Conceptions and Tests of Intelligence* by Peterson (69). A more concise but very readable account of early work in testing with particular emphasis on the kind of contributions made by workers of different countries has been given by Kimball Young (68). Pintner (89) has recently revised his well-known handbook on intelligence tests bringing the material up to date. Because of its convenient arrangement this book is of special value for practical workers in the field of psychometrics. The series of annual reviews on intelligence tests and testing by the same author is very complete. A careful examination of this material will serve to keep the psychometric worker well up to date as to what is going on in his field. (See Part II of the bibliography at the end of this chapter.)

Schieffelin and Schwesinger (86) have recently published a survey of testing devices useful for the study of the relative influence of heredity

and environment upon mental growth. Special emphasis is placed upon non-verbal tests. The chief value of this handbook is to be found in the annotated bibliography of tests and testing materials given in Part III. For each of a series of 186 tests they cite the author, the publisher, the date of publication, the price, the purpose of the test, a brief description of the materials and testing procedure, the time required for giving and scoring, the number and age range of the cases on which it was standardized, the kind of norms available, reliability and validity coefficients, and a series of references. Somewhat more general discussions of the methods and principles of mental testing are to be found in the texts by Freeman (22), Dearborn (18), and others. For the beginning student the chapter on intelligence and its measurement in Woodworth's *Psychology* (66) gives an exceptionally simple and well-rounded treatment of the entire topic.

THE NATURE AND ORGANIZATION OF INTELLIGENCE

Since the early use of intelligence tests was largely confined to the diagnosis of mental deficiency, little attention was at first paid to the question of what "intelligence" is. Up to the middle of the second decade of the present century, attempts at definition were chiefly concerned with descriptions of the behavior of individuals who were lacking in intelligence. As a result we had many definitions of mental deficiency couched in terms of what the mentally defective person is like, but few attempts at defining or describing the trait in which they were alleged to be deficient. Although Spearman had formulated his "two-factor theory" of intelligence as early as 1904 (55), it was not until much later, when, as a result of the extension of mental-testing techniques to include all levels of ability, the question of what the mental testers were really trying to measure was brought clearly to the fore that this theory became the matter of spirited controversy that it is today.

In 1921 a number of leading psychologists were asked to express their views as to the nature of intelligence and their replies were published (57). Although at first reading the points of view seem rather diverse, a little consideration shows that in reality the differences are much less important than they seem. Some emphasized the ability to profit by past experience, others the ability to adjust successfully to new situations. But since the best test of the extent to which an individual has profited by his experience is to be found in his ability to apply the knowledge thus gained to new situations, the two concepts reduce themselves to much the same thing in the end. The same is true of most of the other definitions. Thorndike's pragmatic suggestion that intelligence is shown in the ability of the individual "to make good responses from the standpoint of truth or fact" is certainly in accord with everyday practice both in the judgment of intelligence from behavior and in the scoring of intelligence tests. However it does not offer any clue as to the types of behavior that make most demand upon intelligence. This, of course, is in accordance with

his general point of view that intelligence is not a unitary trait. Terman, on the other hand, makes the distinction very explicitly. According to Terman, "an individual is intelligent in proportion as he is able to carry on abstract thinking." Although some have regarded this point of view as too academic, giving too little weight to the more mechanical and concrete aspects of behavior, nevertheless the fact remains that most investigations have found so low a correlation between the ability to handle abstractions, symbols, relationships, as emphasized by Terman, and the ability to deal effectively with simple concrete situations that it is doubtful whether anything but confusion can result from an attempt to embrace both within a single measure. This is especially true in the case of adults and older children. With very young children the relationship between the concrete visual-motor forms of ability and the more abstract types of thinking is somewhat higher, perhaps because almost any act is likely to make some demand upon the higher thought processes when it is still in process of being perfected. Even with young children, however, the relationship between performance on such relatively concrete tasks as maze learning, ring tossing, pitch discrimination, rate of tapping, and the like is not high (47, 34, 46, 49).

Although the correlations between abilities may be low, they are commonly positive. The question of how this relationship may best be accounted for has formed the topic of one of the most stimulating controversies in the field of modern psychology. Spearman, in a series of brilliant books and essays dating from 1904, has taken the position that all mental abilities can be analyzed into two components. First, there is a general factor known as *g*, which, as it is to some extent common to all mental acts, of necessity brings about some degree of correlation between them. Secondly, there are certain special factors known as *s* factors which are more or less specific to the particular activity or situation in question. Some activities involve the *g* factor to only a slight degree, being chiefly made up of *s* factors, and these will commonly show only low correlations with other mental acts. Others, in which the *g* factor is paramount, will intercorrelate highly with each other. Because this theory is susceptible to mathematical demonstration (although in fairness it must be pointed out that there is not complete agreement among statisticians as to the interpretation of the results), it has attracted much attention and has stimulated a large number of important investigations. In addition to the *g* factor which is essentially intellectual in character, since in Spearman's judgment it involves chiefly the "apprehension of one's own experience, the eduction of relations, and the eduction of correlates," Spearman has obtained evidence for the existence of certain other general factors in mental activity, some of which, as *w* (volition), appear to be related to what is commonly known as "personality." Intermediate between these "general" factors which are shown in all forms of mental activity and the decidedly specific *s* factors, there are others of less complete generality but which are nevertheless common

to a rather wide range of mental acts. To these Spearman has given the name of "group" factors. He suggests that musical ability and mechanical ability are of this type.

Thorndike's view of the organization of mental activities is in certain respects quite the opposite of that taken by Spearman. Spearman takes the position that intelligence, that is, *g*, is a single and unitary trait. Thorndike considers that we have not intelligence but intelligences, that the act and not the trait is the unit, and that the intercorrelations between abilities are the result of overlapping elements in the acts by which these abilities are manifested. He would therefore define intelligence in terms of the kinds of tasks which the individual is called upon to perform. In *The Measurement of Intelligence* (60) he has set forth his position very clearly and in addition has presented a thoroughgoing account of the steps by which one measure of intelligence, which he calls *Intellect CAVD* [since the test used consists of a completion test (C), an arithmetic test (A), a vocabulary test (V), and a directions test (D)], was constructed and cites a number of significant findings obtained from its use. In a supplementary study, Cunningham (17) has applied the lower levels of this test to young normal children and to feebleminded children of a corresponding level of mental development. The outstanding result of the latter investigation is to show the great differences between the two groups in the organization of their abilities. Although their total performance on the test was about the same, there were enormous differences in their relative performance on individual items. Items that were very difficult for the normal children were very easy for the older defectives, and vice versa. Evidently, "difficulty," which is one of the chief mainstays of the constructor of mental tests who is attempting to calibrate his items in equally spaced units, is, after all, a relative affair that may vary considerably with the composition of the group studied. This raises a number of methodological questions, some of which will be considered in the next section.

The Quantification of Intellectual Performance

A tremendous step forward in the study of mental development was taken when Binet published his first "mental-age" scale in 1908. Although the idea of using mental-age standards as a means of gauging the development of individual children had been suggested by Chaille (12) as early as 1887, and although Chaille even went so far as to construct a rough scale for this purpose, covering the first three years of life, to Binet belongs the credit of being the first to develop a testing procedure that had been carefully tried out and that, in spite of certain imperfections, gave a more useful and meaningful way of appraising the child's level of ability than anything else that had been tried.[1] Formerly only crude descriptive

[1] Chaille's article was published in a medical journal of limited circulation. It is highly improbable that Binet was acquainted with it. The "mental-age" idea presumably occurred to each independently.

terms had been available. One might say of a child that he was "very bright" or "very stupid," but just how bright or how stupid remained undetermined. Or one might go further and say that he could pass six or ten or twenty of a series of set tasks, but whether this performance was good, poor, or mediocre could not be known until some sort of standard for comparison had been laid down. Since mental ability increases with age throughout the period of childhood and early youth, the idea of using the performance of the average child of a given age on the tasks in question as a standard with which other children might be compared was almost bound to occur sooner or later. By setting a series of graded tasks and finding out how many and which ones can be passed by the average child at each successive year of age it becomes possible to arrange these tasks, not simply in order of difficulty, but in groups representative of the performance of children of succeeding ages. By comparing the performance of an individual child with these age standards it is possible to express his performance in terms of the age of children to whom his performance most nearly corresponds. Thus a child who does as well on these tests as the average four-year-old is said to have a "mental age" of four, no matter what his chronological age may be. It is like saying that he is as tall as the average child of four or that he takes a four-year size in suits. Any of these expressions gives a much more precise, more nearly quantitative meaning to the child's performance than does the simple statement that he is very much advanced, or that he is somewhat retarded. Taken in connection with his actual age they give a fairly exact idea, not only of the fact that he is accelerated or retarded, but to what extent.

For some years, the only way of expressing the amount of acceleration or retardation of an individual child was to state the difference between his actual or chronological age and his mental age. A child was said to "test" so many years "above age" or "below age." But since the significance of a given number of years' acceleration or retardation varies with the age of the child the use of the "intelligence quotient," or IQ, first proposed by Stern and popularized by Terman in the Stanford Revision of the Binet tests (58), gained rapidly in popularity. The intelligence quotient, which is the ratio between the mental age and the chronological age, was at first assumed to have a constant meaning regardless of the age of the child. For this reason it was often spoken of as an "absolute" measure of intelligence. More recent work, however, has shown that this is not always the case. Unless certain constant relationships are maintained between the dispersion of test scores at each age and the averages or "norms" for the successive ages, the IQ cannot remain constant either for individuals or for groups. This point has been discussed by a number of different persons, and especially by Freeman (22, 23). For example, if the curve of mental growth from age to age is assumed to be a straight line, as is done when the tests are arranged in the form of a "year scale" with an equal number of tasks at each age,

then the dispersion of mental ages must increase from age to age in a ratio that is proportionate to age. If at the age of six the standard deviation of mental ages is 12 months, then at the age of nine it should be 18 months, at the age of twelve it should be 24 months, and so on. If this condition is not met, then an IQ of 120 earned at the age of six will not be comparable in meaning to one of the same apparent value earned at some other age. If the tests are not arranged in year groups but in some other order, say in order of difficulty, and the number of items passed at each age is taken as the norm for that age as was done in the so-called "point-score" procedure, some definite relationship between the successive age increments and the dispersion of scores must still be maintained. What that relationship should be will depend upon the form of the growth curve for the test in question. If the curve follows the form of a logarithmic series, then the dispersion of test scores should be equal at all ages. If it follows some other form, the dispersion of test scores must change accordingly in such a way that the overlapping of scores from age to age will increase in proportion to age (22, p. 280). In the case of a few tests, notably the middle ranges of the Stanford-Binet, the necessary conditions appear to be fairly well fulfilled, but the uncritical use of the IQ technique for any and all tests for which age standards have been worked out is unwarranted.

A number of other methods for interpreting test scores have been suggested. The "coefficient of intelligence" proposed by Yerkes, Bridges, and Hardwick (67) is the ratio between the number of items passed by an individual child on their "point scale" and the standard for his age. The "index of brightness" first proposed by Otis was found by taking the difference between the child's point score and the standard score for his age and adding or subtracting this from 100 according to whether the difference was plus or minus. Neither of these methods met with extensive use, and in the 1923 revision of the point scale the IQ was substituted for the CI largely because the results, while superficially resembling the IQ, were found to be actually incomparable with it. Moreover, neither the CI nor the IB was found to yield consistent results from age to age. An able discussion of the inconsistencies resulting from the use of "quotient" methods with tests that do not meet the conditions necessary for their validity has been given by Rand (51).

During the last few years the "percentile" method of interpreting test scores has become increasingly popular. The percentile score, or, as it is often called, the "percentile rank," is expressed in terms of the percentage of a specified group, usually of the same age, whom the child in question surpasses. The fact that any group may be used for comparison gives the percentile method a degree both of flexibility and of specificity that the methods previously described lack. A mental-age norm is always, supposedly, representative of children in general of the age in question. But a little consideration will show that it is rarely possible, in the actual standardization of a test, to secure the truly representative group that is

implied by the term "mental age." This difficulty has been recognized theoretically by practically all workers, nevertheless the idea that the "mental-age norms" which have been worked out in the course of the original standardization of a test have some kind of final or absolute value is implicit in most of the interpretations of results obtained for different groups by the use of various tests. Moreover, it is but rarely that we are actively concerned with a comparison between *individuals* in non-competing groups. Ordinarily we compare college students with other college students, preferably of the same class. We are likely to be more interested in knowing how the eight-year-old daughter of a college professor compares with the eight-year-old offspring of other college professors or with the other children in her class at school than in knowing how she compares with the eight-year-olds in a backward mountain community or with the eight-year-old Negroes on a Louisiana plantation. Comparisons between contrasted *groups* of this kind are often interesting, but for this purpose other methods of quantifying test results are more suitable than the quotient methods so often used.

The percentile method has other very obvious advantages. It is easily understood even by the uninformed and is therefore particularly useful in explaining test results to parents, teachers, physicians, and others who may be interested. Since comparisons are made only between individuals of the same chronological age, the implications resulting from assigning equal basic scores to individuals of very different levels of physical maturity and life-experience are avoided. An imbecile of fifteen with a mental age of three is a very different kind of human being from a normal child of three years even though he may happen to pass the same number of items on a certain "mental test." Even his test score, while it may count up to the same number of items, will usually show decided qualitative differences in the particular items passed and the kind of responses that are made to them. When differences in chronological ages are not too great, the mental-age method of comparison is useful. When mental testing was first begun it served a valuable purpose in calling attention to certain gross similarities between the performances of backward children and those of younger normal children, thus giving a more exact idea of the level of accomplishment for which the backward child might fairly be held responsible. As techniques become more refined it is likely that the use of mental ages and IQ's will gradually be replaced by other devices for interpreting test scores the meaning of which is more precise.

Although when properly used and interpreted the method of percentile ranks is a simple and valuable device for reducing test scores to meaningful quantitative terms, it must not be forgotten that, unless the distribution of test scores takes the form of a rectangle instead of the usual normal curve, the distance between successive percentiles cannot be equal. Instead their values will increase steadily toward each extreme. This is easily understood if it is remembered that the percentiles are computed on the basis of the percentage of cases making each successive

score, that is, in terms of the areas of successive segments above the base line of the curve. If the distribution of scores approximates the usual bell-shaped form, equal areas will subtend longer and longer segments of the base line as the extremes of the distribution are approached. The difference in score value between the ninety-seventh and the ninety-eighth percentile will be far greater than that between the fifty-seventh and the fifty-eighth. Percentile ranks, therefore, while they are useful methods for expressing individual standing within a specified group, should never be used as media for further computation. They cannot, justifiably, be added or subtracted or averaged. Neither do they lend themselves to the conventional forms of graphic expression such as bar diagrams or histograms. They are interpretative measures only.

Another method of expressing the test standing of an individual is in terms of the number of standard deviations by which he falls below or surpasses the mean standing of his group. As in the case of percentiles, the group may be defined in any way desired. However, if age is taken as a basis for the definition, then the range of ages used for determining the standard deviation should equal those used in defining the age of an individual child. That is, if the ages of the children are taken to the nearest month, then the standard deviations used in computing the scores should be calculated within the limits of dispersion shown by children whose ages vary only within a month's range. The point is a rather obvious one and is mentioned only because it has frequently been disregarded when this method of expressing scores has been used.

Logically, the question of scaling test results in such a way that the distances between successive scores take on approximately the same value should have been considered before describing the interpretative procedures by which the test results are given concrete meaning. However, with the exception of a number of educational scales such as the Thorndike scale for judging the quality of drawings (59), the work on scaling techniques is, for the most part, a comparatively recent development in the field of psychometrics. A crude kind of scaling was accomplished by the age-scale method in putting together tests passed by children of a given age and utilizing only a given number of tests at each age level, but, as a rather wide latitude was allowed in regard to the percentages of success by which the placement of a given test at a particular age level was decided and the form of the growth curve was arbitrarily assumed to be a straight line, the method was far from exact.

With recent advancements in statistical techniques and the application of more rigid procedures in "testing the tests," problems of scaling have received more general attention. The so-called "point-score" method, which was simply a counting of items, disregarded entirely the question of the relative difficulty of these items apart from arranging them in approximate order of difficulty. But there was little or no attempt to equalize the steps from one item to the next. Chance selection usually resulted in very unequal spacing, particularly at the extremes. The

irregular overlapping resulting from the unequal spacing made it impossible that the intelligence quotients calculated from these tests should have equivalent meanings at different ages even within the limits of the same test. When different tests were used the discrepancies were likely to be even more glaring. A number of scaling procedures designed to overcome these irregularities have been worked out and applied both to the older tests first standardized on the basis of a simple item-count and to newly devised tests. Thus far, scaling methods have been more generally applied to the educational tests for the measurement of accomplishment in the different school subjects than to intelligence tests, but work on the latter is well under way and it is to be expected that in the future the question of scaling will be given much more attention in the construction of tests of all kinds than has been done in the past. Among the tests in present use for which norms are given in terms of scale values the Arthur Performance Scale (5) and the Minnesota Preschool Tests (35) may be mentioned. The procedure used in deriving the scale values for the Arthur tests is the so-called discriminative-value method (D.V.) proposed by Arthur and Woodrow (6). In scaling the Minnesota tests the C-score method used in a number of educational tests was used. Thorndike's work on the CAVD tests has already been mentioned. This is one of the most thoroughgoing pieces of methodological work that has appeared and merits careful study. In the same volume scale values for a number of the leading intelligence tests originally standardized on an item-count basis are also given.

Although the question of scaling is so fundamental a problem in all attempts at mental measurement, there is as yet no general agreement as to which of the various methods that have been employed will yield the most consistent results. Thurstone, who has developed a method of scaling based on the overlapping of scores at successive age levels, is very critical of any method which takes account of variability only within a single age group. His method results in scale values which appear to yield an approximately linear relationship between age and variability, a condition which, as was pointed out in an earlier paragraph, is necessary if quotients are to have the same relative significance from one age to another. Although the true linearity of this relationship has been called into question by Holzinger (39), the error appears to be much smaller than that which would result if scores derived from a single age group were used as the basis for scaling as Holzinger recommends.

Since the values derived from the so-called "absolute-scaling" methods will vary according to the method employed and the extent to which the empirical data correspond to the assumptions under which these methods have been worked out, it is evident that at best the equality of spacing which these methods are presumed to yield is only approximate. It is undoubtedly an improvement over the old item-count method, but much further work needs to be done before we can be certain how and to what extent the results are affected by variations in the conditions of test-

ing and in the sampling of subjects upon whom the test was standardized. All methods of scaling derive their units from the proportion of children at each age who pass each test item. Cunningham (17) has shown that even with so carefully standardized a test as the CAVD differences between the performance of adult imbeciles and normal children between the ages of two and a half and six years on the separate items of the test are in some instances as great as ten times the standard error. Merrill (48) found decided differences in the performance of gifted, average, and subnormal children of the same mental age on the different items of the Stanford-Binet. The groups also differed considerably in the amount of "scatter" on this test, that is, in the range which it was necessary to cover in order to meet the usual conditions of complete testing. Both the gifted and the subnormal groups "scattered" decidedly more than the group of average ability. Aldrich and Doll (1) matched normal children of nineteen to thirty-eight months with idiot boys of corresponding mental ages and compared their performance on the Gesell developmental items and on the Merrill-Palmer series of performance tests. The idiots were markedly inferior to the normal children on all tests involving language but were superior in the tests involving experience and the use of concrete materials. Although the matter has not been adequately tested, it seems highly improbable that scale values can maintain their equality of spacing except for groups that are reasonably similar to the one on which the values were derived. This point has been recognized to some extent. Thurstone (63, p. 178), for example, specifically states that "the social and intellectual factors of selection must operate more or less uniformly for the several age-groups" if the conditions requisite for his method of scaling are to be observed. Thorndike (60) has pointed out additional sources of error. The ordinary criterion of test difficulty is the relative frequency with which it is passed. A test that is passed by few children at a given age is regarded as more difficult than one which the majority can answer. But the frequency of passing is determined not only by intrinsic difficulty but by the extent to which the fact in question has become a matter of general knowledge, that is, the likelihood that all or most of the children will have had opportunity to become acquainted with it. The word "broccoli" is not intrinsically more difficult than the word "spinach" or "cabbage," but until the last few years at least it would unquestionably have been classed much higher in a vocabulary test. Whether or not the concepts of elementary algebra are intrinsically more difficult than the concepts of long division is uncertain, but because most schools teach long division before elementary algebra more children will succeed with division problems than with algebra problems. Probably more city children than country children of the same age will be able to give a correct answer to the question, "What must you do if you are going some place and miss the trolley car?", but if the question were, "What must you do if the cows break into the wheat field?" the opposite ten-

dency might be shown. Sherman (53) reports that many of the mountain children whom he studied were unable to give their family name, identifying themselves simply as " 'Lizy's Tom" or "Mose's Joe." Giving the family name is a test for three-year-olds in the Stanford Revision of the Binet, but if the three-year-olds upon whom this test was standardized had been asked to give their father's or their mother's first name, they might have been no more successful than the mountain children were in giving the family name. The difficulty of a task for any group is in part a matter of its familiarity or strangeness for that group. It follows that "scale values" though they may be equally spaced for a particular group are likely to be quite unequally spaced for another group of similar intelligence but different experience. No matter what method of quantifying test results is used, the standards obtained cannot safely be applied to other groups unless it has been shown that the latter are reasonably similar to the standardization group in all matters that may be expected to affect the relative value of the scores. In order that such comparisons may be made it is essential that the main characteristics of the group used in standardization be defined as exactly as possible. This means that some information about the home background of each child needs to be obtained. While elaborate social case histories are usually out of the question and would be difficult to handle in any case, a few simple facts such as paternal occupation and residence (city, town, or rural) are easy to ascertain, and if these were uniformly classified and reported as a part of the routine information concerning every test that is worked out many of the discrepancies that result from the use of differently standardized tests could be explained and the suitability of a particular test for use with a given group of children could be more safely judged. The relationship between socio-economic status and mental-test standing will be considered further in a later section.

Mental-Growth Curves

A natural outgrowth of the attempts to calibrate mental tests in truly equal units is the plotting of the results thus obtained in the form of growth curves. Gesell (28), influenced by the apparent magnitude of the early changes as compared with those occurring later, presents a hypothetical curve with increments following a logarithmic scale. The only empirical basis for this curve is subjective judgment as to the comparative rate of changes in behavior from age to age that has been derived from the very careful and thoroughgoing studies of infant behavior patterns that have been carried out in the Yale laboratory during the past decade. Thorndike (60) points out the need for distinguishing between *altitude* of intellect which is measured in terms of the difficulty of the tasks that the individual can perform and *range* of intellect represented by the number of tasks at a given level of difficulty that he can do correctly. He finds that for Intellect CAVD the growth curve for altitude is parabolic in form, rising from 0 at birth to about 30 at six and a half

and to about 36½ for adults twenty-one years old. The curve for range has not been determined, but he suggests that it may be positively accelerated.

The location of the zero point has been a source of major difficulty in all attempts at extending growth curves backward to the time of birth. Thurstone (63) has suggested a method which has the merit of being objectively determined and which meets the common-sense criterion that, although the point of origin is determined independently by extrapolation of the curve from the data obtained by tests given to older children, nevertheless in each set of data for which curves have been derived the absolute zero thus obtained coincides very closely with the date of birth or a date shortly before birth. As Thurstone points out, the latter condition is not unreasonable since it is probable that mental growth (in the sense of the development of distinct behavior patterns) probably has its origin some time during the fetal period. The method of constructing these curves is based upon Thurstone's finding that "with uniform conditions of selection there is a linear relation between absolute variability and mean test performance of successive age groups." From this it is assumed that the absolute zero of the test score must lie at the point where variability disappears, since in the nature of things variability cannot be negative. When growth curves for various tests are constructed and the curve extrapolated backward to the zero point it is found that the National Intelligence Tests, the Merrill-Palmer tests for preschool children, and the Otis Advanced Examination all show approximately linear curves extending from birth to the limits of maturity measured by the test. The Burt Revision of the Binet tests, however, shows a curve markedly different from any of these, being distinctly curvilinear with decided negative acceleration. Thurstone does not offer any explanation for this discrepancy. Since then Thurstone and his students at Chicago have worked out growth curves for other tests some of which show negative acceleration while others seem practically linear. The reason for the differences is not clear. The question is rendered still more puzzling by a study in which Thurstone and Ackerson (64), after scaling the data from the Stanford-Binet tests given to 4208 cases at the Institute for Juvenile Research, find a curvilinear relationship to age with marked *positive* acceleration at the younger ages and an inflection point somewhere about the age of eleven years.

Courtis (16) approaches the question from a different angle from that of other investigators. Instead of trying to work out a total growth curve based on a composite of many tasks, he begins by considering the curve of growth for a single item. After plotting curves for many kinds of biologic growth, ranging from the growth in weight of a pumpkin to gain with age in the percentage of men who are married, he derives a unit called the *isochron* which is defined as the percentage of the total period of maturation that has been attained by any individual or group at any time. By means of a series of conversion tables isochronic values may be read directly from

the percentage passing a given test at each age and growth curves plotted in terms of units which, Courtis thinks, have uniform significance for all forms of biologic growth, either of structure or function. The idea is an interesting one and if its validity is confirmed by further investigation the method will lend itself to the study of many problems of development for which other techniques seem poorly suited.

All these varying results seem to point clearly either to the conclusion that there is no single curve that is representative of mental growth in general or that, as Courtis believes, there is a single type of curve that is typical for the development of a single mental act or operation and the apparent variations in the form of the curves taken by composite tests made up of many such unitary acts are due to the fact that since the acts vary in difficulty their periods of slow and rapid growth will be combined in many different ways according to the way the items are selected. If successive items are so chosen that the period of slowing-down in the growth of one item is exactly compensated for by the bringing-in of another item whose growth is just getting under way, the form of the composite curve may be linear. If new items are brought in more rapidly than is needed to compensate for the slowing-down of functions that are approaching their limit of development, the curve may appear to be positively accelerated; if the addition of new functions is insufficient to compensate for the slowing-down of those already active, negative acceleration of the total curve would result. If this is the case it seems doubtful whether the growth curves obtained for composite tests can be said to have any generalized meaning since their form will be entirely a function of the particular items of which they are composed. No test can possibly include more than an infinitesimal sample of the total behavior of an individual.

On the other hand, the studies of both human and animal learning seem to point to the conclusion that, while there is no single type of curve that characterizes all forms of learning, nevertheless there are certain typical curves which appear quite uniformly in learning certain specific kinds of tasks. The curve for maze learning, for example, shows marked negative acceleration in time and errors both for human beings and for animals. The curves for the learning of fairly complicated acts of skill such as ring tossing usually show rather slow gain with many irregularities and no very clear-cut tendencies toward either negative or positive acceleration. The curves for problem solving where the grasping of some general principle is involved (as in mechanical puzzles) usually show slow and irregular improvement up to the time when "insight" into the principle is gained, followed by a sudden and marked shortening in the time requirement and gain in regularity of the time curve. Curves for the learning of foreign languages usually show positive acceleration as command of the general principles is gained. It is very possible that measurements of mental growth, which, after all, are nothing more than measurements of what has been learned (on the basis of which we make certain assump-

tions as to capacity to learn), may also show varying curves of progress according to the nature of the tasks set.

Two further questions on the form of the mental-growth curve need to be mentioned. The first is the relationship between level of intelligence and gain in intelligence. Kuhlmann (41), in an article that has been much quoted, presents evidence to show that the intelligence quotients of the feebleminded tend to decrease slightly with age, and that their development ceases at a somewhat earlier age than does that of normal children. Heinis (37) is of the opinion that this is a necessary result of the uncorrected quotient method of specifying test results and suggests a substitute method which he calls a "personal constant," computed from a growth curve constructed on the basis of Kuhlmann's data in such a way that the tendency for the individual differences in IQ to increase with age (high IQ's becoming higher, low IQ's becoming lower) is corrected. It has not been shown whether or not the same method would apply to other tests, and in view of the many complicating factors previously discussed it seems very doubtful that any of the results obtained by our present techniques are sufficiently independent of the techniques themselves to give any reply to the real question involved. It is entirely possible to adjust our measuring instruments in such a way that individual differences will appear to increase, to decrease, or to remain constant, but what the facts would be if ascertained by a truly absolute scale is uncertain.

The second question has to do with age at mental maturity. In the Stanford Revision of the Binet, which was long regarded as the standard measurement, mental growth was assumed to continue at a constant rate to the age of sixteen years and then abruptly cease. The abruptness, of course, was a function of the way the scale was constructed rather than a basic concept. The IQ technique makes no provision for a gradual slowing-off in rate of growth. The sixteen-year level was chosen on the basis of the performance of high-school children and a limited number of employed persons, who in general showed little change in performance after the age of sixteen on the tests used in this scale. Later, as a result of the Army testing which appeared to show that the average recruit had a mental age of thirteen and a half years, it was felt by many that the sixteen-year standard was too high. Fourteen, fifteen, in some cases even thirteen, years was proposed as a substitute. It has been shown, however, that this low average was the result of a number of factors, such as differential selection owing to the fact that the men in the medical corps and the officers' training camps were not included, unfavorable conditions under which the tests were given in many instances, etc. Most psychologists now seem to be of the opinion that, while mental growth like physical growth probably advances at a much slower rate during late adolescence than at the earlier ages, it does not completely cease before physical maturity has been reached. Thorndike (60), after citing the

results of several independent investigations, comes to the following conclusion:

> "Neither in our CAVD results, nor in the National-Otis-Haggerty estimate nor in Brooks' results is there any justification for the doctrine that the gain in altitude of intellect of the sort measured by existing intelligence tests is zero after 14 or after 15, or even after 16. It decreases, but it should not become appreciable until 18 or later. According to our results the decrease from 14 to 18 is not an abrupt slowing up of a gain that has been steady hitherto, but is part of a general negative acceleration which began long before the age of 6½ . . . . . It is also the case that after a person acquires a certain amount of general linguistic and mathematical ability, and of general information about the sort of things which everybody is ashamed not to know, he usually devotes his mental abilities to the specialized abilities useful in his trade, business, or profession, hobby and social circle. . . . . These specialized abilities may begin their rapid rise in altitude at an age when CAVD altitude has almost ceased to gain" (pp. 467-468).

The Correlation of Intelligence with Other Factors

Paterson (50) has reviewed the literature on the relation of physique and intellect so thoroughly that it is unnecessary for me to do more than state his general conclusion, which is that under adequate conditions of measurement the correlations of bodily form and size with intelligence test results are more frequently positive than negative but are of so low a magnitude as to be worthless for purposes of prediction. It might be added that in practically none of the published studies have such factors as race and socio-economic status been adequately controlled. It is quite possible that even the small positive correlations that have commonly been reported may mean nothing more than that children from the better socio-economic classes are likely to be a little more intelligent and a little better developed physically than those from poorer homes. If this is true, some correlation between the two measures would be expected in a random sampling of the population even though no intrinsic relationship might exist.

Although the attempt to find gross physical correlates of mental traits seems pretty well abandoned, it seems probable that neurological correlates must be present even though we do not know just where or how to seek them. The work of Lashley (43) throws much doubt on the old ideas of narrowly localized cerebral functions, and experimental neurology is fast upsetting other cherished ideas as to the physical basis of learning and thought. On the positive side, we have a number of animal studies such as those of Coghill (15) showing the close parallelism between neurological development and the differentiation of behavior patterns in Amblystoma. Doll and his associates in the Vineland laboratory (20) have made a very thoroughgoing study of mental deficiency due to birth injuries from which they conclude that this is a far more important

factor in the etiology of mental backwardness than has formerly been supposed. It is through studies such as this that the nature of the relationship between mental and physical development seems most likely to be discovered.

Motor skills and the simpler perceptual skills show little if any closer relation to intelligence test scores than do physical measurements. At the younger ages the relationship is likely to be somewhat higher than for older children, but this may be because intelligence tests for younger children usually include a larger percentage of motor elements. Such relationship as exists appears to be largely due to the fact that children who are backward intellectually are also likely to show some degree of motor retardation, but the intellectually superior differ but little from those of average intelligence in motor traits. A number of specific studies on this topic have been reviewed by Wellman (65) in the first edition of this *Handbook*. The relation of intelligence to other special abilities and to personal and social traits is discussed elsewhere in this volume and so need not be especially considered here.

The question of possible race differences in intelligence can be given only a brief discussion. It has repeatedly been shown that the children of American Indians, American Negroes, and those of certain immigrant groups rank distinctly lower on most of the standard intelligence tests in common use (25, 29) than do the children of native whites. This is a fact which cannot be gainsaid. But a given fact may be due to any one of several causes or to a combination of them, and, as many have pointed out, these apparent race differences may be the result of cultural factors associated with the conditions under which the groups in question have lived rather than to factors intrinsic in the particular race or nationality considered. Language handicaps in the case of children who come from homes where a foreign language is spoken, emotional inhibitions when Negro children are tested by a white examiner, and selective immigration of the less intelligent members of foreign groups to this country are other possibilities. In a question with so many scientific implications it is to be regretted that so few investigations have been designed to test in an unbiased manner these and other hypothetical explanations for the differences found. A proposal frequently made, but never, so far as I know, carried out, would be to devise a test that proved as successful in measuring individual differences within the culture in question as do the intelligence tests now used for measuring such differences among the children in our own cultural group, standardize it upon children from the group for which it was originally designed, and compare their performance on this test with that of American children.

Sex differences in intelligence test scores are usually small and are shown chiefly on certain kinds of tasks rather than on total performance in a composite scale where some items are likely to favor one sex, others the opposite sex (2, 30). As in the case of natio-racial differences, it is impossible to say from present evidence whether the small differences

that are commonly found are the result of early differences in the kind of training and social stimulation given to the two sexes or to more fundamental differences associated with the biology of sex. That sex differences in preference for certain toys exist as early as the age of two years has been shown by Benjamin (10), and that these differences are stimulated and fostered by parents is demonstrated by a study by Skalet (54) of the kind of toys usually provided for children of preschool age in the home.

Even before the days of intelligence tests the idea that some degree of segregation of intellectual levels within different socio-economic classes had been put forth. Beginning with the publication of Galton's *Hereditary Genius* in 1869, repeated investigations have shown that a disproportionate number of eminent men of all classes come from the upper socio-economic levels, while the laboring classes contribute relatively few in proportion to their frequency in the population. Obviously, this fact can be made to support either the hereditarian or the environmental point of view. Without committing ourselves to a bias in either direction, it is worth while to examine the facts.

Once intelligence tests came into use it became apparent that not only was there segregation of abilities along socio-economic lines among adults, but that the children coming from different socio-economic classes showed differences well-nigh as great as those exhibited by their parents. Among the first to call attention to this point were Decroly and Degand (19) who gave the Binet 1908 scale to forty-five children attending a private school in Paris and found that, while none were below Binet's standards for their respective chronological ages, 80 per cent tested from one to three years above age. On the basis of these results the authors were inclined to question the adequacy of Binet's norms, but Binet himself (11), in a critical discussion of the findings, offers the suggestion that the difference in the social status of these children as compared to those used in the original standardization of the scale was in the main accountable for the discrepancies found. Since that time Binet's position has been shown to be well warranted. Repeated investigations have shown that children from private schools of the better class usually rank superior on ordinary intelligence tests to those from the schools attended by the masses (3), that a distinct relationship exists between the amount of education achieved by the parents and the intelligence test standing of children (31), that the intelligence test scores of children vary according to the occupation of their fathers, the children of the professional classes ranking highest on the average, while the children of day laborers rank lowest (36), and that other measures of social status, such as the Chapin living-room score (13) and the Sims score card (14), also show a distinct relationship to the intelligence test scores earned by children. This has been found true not only in America, but in England (21, 40, 45) and other foreign countries. The differences found seem to be about as marked at the very early ages as among older children (32). This last fact is of considerable importance, for if differences in environmental

status are responsible, then environment must get in its work at a very early age.

Anderson (4) has shown that socio-economic status is related to a very wide variety of different aspects of child behavior and that it is hard to find any item in the material or social environment that does not to some extent vary with social class as indicated by paternal occupation. No matter what the etiological relationship may be, the finding has a most important bearing on all studies of child conduct, whether in the intellectual field or elsewhere, since it calls attention to the necessity of reporting the social status of the subjects used in any investigation if results are to be interpreted in a uniform manner.

Mental Tests and Prediction

Almost from the beginning, an important difference between the practical uses of mental and physical measurement has existed. In measuring height and weight the interest centers about the child's present status. Although it has been shown that a considerable degree of relationship exists between individual differences in physical size from one age to another, tall children tending to remain tall, heavy children to remain heavy (7), nevertheless the prediction of future status is not the chief aim of the anatomist who measures the physical dimensions of the growing human body. With the mental tester, however, the case has been quite different. In the beginning the use of mental tests was largely confined to the selection of backward children for assignment to special classes and of feebleminded for consignment to institutions. In the latter case, at least, the idea that the mental test had predictive value was inherent in the use to which it was put. Within a decade after intelligence tests had first come into widespread use in this country the doctrine of the "constancy of the IQ" had been adopted with almost religious fervor by many who were quite unaware of the limitations within which this concept has been found to hold good. The demonstrated facts are that when certain tests, notably the Stanford-Binet, are repeated with the same children at intervals varying from a few days to several years the children tend to maintain much the same position with reference to each other from age to age provided that they were at least six years old at the time of the first test. This tendency is not absolute, however. Marked changes sometimes occur, and small changes are to be expected. Studies of the consistency of the performance of school children on retests given after a lapse of time have been reported by many persons with closely similar results. The correlations between the successive IQ's usually range from about .80 to .90 or slightly higher, depending in part upon the range of talent included and in part upon the uniformity of testing conditions and the training of the examiners. In terms of changes in IQ, most studies have shown that about half the cases will not vary by more than 5 IQ points in either direction, or in other words, that later IQ can be predicted from earlier IQ within a range of 10 points in about half the

cases. In the remaining half, the variation will be greater than this amount. A study by Hildreth (38), of which the results are fairly typical, shows that in 4.3 per cent of children first tested after the age of six years changes upon retest of 20 or more points of IQ were found. This means that in the class of average size from one to two children, on the average, are likely to change their standing upon retest to a degree that would decidedly modify any recommendations that might have been made on the basis of the original testing alone.

When tests other than the Binet are used, particularly group tests, the consistency of results upon retesting with the same test is less than that reported in the last paragraph. Few correlations covering periods greater than one or two years have been reported, but even for this interval the correlations rarely exceed .80 and are frequently much lower. When different tests are used, irregularities of standardization from one scale to another are likely to make the results decidedly incomparable, even though the interval between testings is very short. This fact is strikingly brought out in a study by Sangren (52) who gave seven of the best-known primary group tests to 100 first-grade children within an interval of three days. All the children were likewise tested with the Stanford-Binet within two months of the time that the group tests were given. The most striking results of this experiment are to be found in the great differences in the distributions of mental ages as computed by the various tests. The means of the mental ages vary from 84 to 96 months, the standard deviations from 9.8 to 16.9 months. On one test the range of mental ages is from 57 to 133 months; on another the range is from 25 to 89 months. Some of the distributions show marked positive skewness; others are negatively skewed; in others the distribution is approximately normal. An IQ or a mental age earned on one of these tests is by no means the equivalent of one of the same apparent magnitude earned on another.

For children under the age of six, the tendency toward IQ constancy is much less marked than it is for older children. In Hildreth's study (38), although only 4.3 per cent of the children over six at the time of first testing varied as much as 20 points upon retest, 19 per cent of the children under six varied to this extent. Other workers have reported similar results. Whether the lack of agreement between successive tests in the case of young children indicates that true fluctuations in mental-growth rate are more likely to occur at these ages or is merely the result of less reliable techniques of mental measurement suitable for young children cannot be determined from the data at hand. Difficulties of securing adequate motivation, emotional factors such as undue shyness or timidity, poorer selection of test items, and the small size of the denominator used in computing the IQ are all factors likely to reduce the dependability of an intelligence test result obtained from a very young child. On the other hand, if it is true that mental growth proceeds most rapidly in the early years, then the constancy of individual differences shown after

the age of six may be in large measure due to the fact that the increments occurring after that age are so small in proportion to what has already been gained that changes in their amount will affect the total standing very little. We know that the brain has attained 90 per cent of its final weight by the age of six years. Thorndike calculates that approximately 82 per cent of the final altitude of Intellect CAVD has been reached by the age of six and a half. In the absence of a test that is sufficiently accurate to measure the gain from one testing to another independently of test standing on the first occasion, it is impossible to say whether or not individual *growth rate* possesses much or little of the "constancy" that has sometimes been unthinkingly ascribed to it as a result of the observation that individual differences in *mental status* do not as a rule change greatly after school age has been reached.

Thus far practically no data are available to indicate just how great is the value of an intelligence test given to a child of two or three years for predicting his intellectual status several years later, say in high school or college. Most of the studies dealing with young children have not covered long periods. Preliminary results of a seven-year study now in progress at the University of Minnesota Institute of Child Welfare indicate that the reliability of prediction is a function both of the age of the child at the time of the first test and of the interval between tests. Other things being equal, the younger the child or the greater the interval the lower will be the correlation between original test and retest. Nevertheless, even tests given as early as two years appear to have some predictive value, at least over a period of four or five years, if the test has been carefully standardized and good cooperation is secured from the child on both occasions.

Modern attempts at developing scales for measuring mental development of infants during the prelinguistic period may properly be said to date from the publication of Kuhlmann's revision of the Binet scale (42), which was published in 1922. This scale was the only one available for use with young infants until the publication of the Gesell developmental schedules (27, 28), which, although not formally organized into mental tests of the kind that yield a definite quantitative score, have attracted much attention among persons interested in mental testing. In both these books, as well as in the numerous and valuable special studies that have come out of the Yale laboratories, the regularity and orderliness with which the development of behavior patterns proceeds, the significant and distinctive changes that take place from age to age, the amazing uniformity as regards the order of appearance of the different developmental items from one child to another, together with the great individual differences in the time of their appearance in different children, present a picture of a dramatic sequence of profound importance for the biological study of human development.

Because of the two facts last mentioned, viz., the constancy of the developmental order of appearance of the various items, together with

the great individual differences in rate of development shown by individual children, it has been tacitly assumed by many persons that the normative items described by Gesell will yield a reliable indication not only of the course which development has followed up to the time of the examination (that is, of present developmental status) but also that such tests will yield a reliable basis for predicting future development. Gesell himself (28) implies that this is the case. However, certain investigations which have recently been made seem to cast considerable doubt upon this assumption. At the Catholic University of America, Linfert and Hierholzer (44), under the direction of Furfey, worked out a series of infant tests modeled in large part after the developmental items described by Gesell. These tests were given to a group of fifty infants at each of the following ages: 1 month, 2 months, 4 months, 6 months, 9 months, and 12 months. By the "split-scale" method reliability coefficients ranging in value from +.70 to +.88 for the various ages were obtained. There was a steady increase in score from age to age, showing that the tests at least measured some function that was increasing with age. All this looked very promising.

Approximately four years later more than half of the infants first tested at 6, 9, and 12 months of age were located and given the Stanford Revision of the Binet test (24). The correlations between the two tests were as follows: For twenty-seven infants first tested at the age of six months the correlation was —.11±.13, for twenty-six cases first tested at nine months the figure is —.34±.11, for the twenty-eight cases first tested at twelve months, —.20±.12. It is evident that the infant tests used in this study are of no service whatever in predicting individual differences in standing on the ordinary type of intelligence test even at the four-year level.

Similar results have been obtained by Bayley (9) in a study carried out at the Institute of Child Welfare of the University of California of which only preliminary results have so far been published. The California study is based upon a longitudinal investigation of the development of a single group of sixty infants from birth on. All the infants were brought to the Institute laboratory for examination at monthly intervals during the first year, thereafter at three-months intervals. The mental tests used were in large part modeled after the developmental schedules of Gesell, but the method of giving and scoring the items was more rigidly defined. When correlations between the tests given at varied intervals were worked out, it was found that there was a constant tendency for the correlation between tests to decrease as the length of the interval between the tests increased. Correlations between successive tests increased steadily as age advanced. The correlation between the first and fourth quarters of the first year is only +.28 and before the end of the third year the relationship between the early tests and those given later has become slightly negative.[2] Although this small negative

[2]Information given the writer by H. S. Conrad, of the University of California Institute of Child Welfare.

relationship (which also appears in all three of Furfey's groups) is unexpected, each is so small that considered individually it may well be a chance departure from zero. Until confirmed by further studies this seems the safest explanation. These studies, however, offer rather convincing proof that our present methods of measuring mental development during the first year of life do not provide a useful basis for predicting the future development of the individual.

Several explanations for these findings are possible. First of all, the nature of the test items must be considered. Previous to the beginning of speech it is difficult to isolate forms of behavior which can be said to have a truly symbolic character. Actually most of the items used in these tests have to do with simple sensorimotor manifestations that do not bear very much overt resemblance to the forms of behavior which have been found to be useful signs of "intellectual" development at later ages. In this connection it is well to remember that the earliest attempts at mental testing of older children and adults in America also made use of very simple sensorimotor acts, and that the results of these tests showed very little relationship to such matters as school progress, standing in the various school subjects, estimates of ability by teachers, or other measures of the kind. It is entirely possible that in our attempts to gain complete objectivity by analyzing the behavior patterns of young children into very small elements we have fallen into the same error that was made by the American mental testers of an earlier date. Perhaps at some time in the future a second Binet will appear who will be able to look beyond the simple motor performances which thus far we have been attempting to study in the young child and will see in his behavior certain broader patterns of abstraction and comprehension by means of which later mental growth can be predicted with a degree of certainty that the present infant tests do not seem to warrant.

Discussion

In the treatment of this topic more emphasis has intentionally been placed upon the inadequacies and imperfections of our present methods of mental measurement than upon their positive values. The latter have been thoroughly demonstrated. In spite of minor inaccuracies, in spite of disagreement as to exactly what it is that we are trying to measure and uncertainty as to what units we shall employ for expressing the results of our measurement, the fact remains that for most purposes and in most cases the tests work amazingly well. In the schoolroom, the behavior clinic, the office of the vocational counselor, the juvenile court, the child-placing agency, their practical value has repeatedly been shown. In one sense it may be said that in the success with which they have been used lies their greatest weakness, for in too many cases this successful use has engendered a blind faith in all test results to which some kind of numerical score is attached. Figures are likely to exercise a hypnotic effect upon most of us. Although we may know that the significance of

a test score varies with the test used, the conditions under which it is given, and the age of the child tested, nevertheless even the well-informed are often far too prone to feel that, once it has been calculated, an IQ is an IQ and nothing can change it. Fortunately, this attitude is beginning to disappear. A comparison of the literature on mental tests that has been published during the last five years with that which appeared a decade ago shows a most encouraging shift from the wholesale production of new and half-tried testing devices to the critical examination of the significance and accuracy of those already in use. Improved statistical methods have been applied to problems of scale construction as well as to the investigation of sources of error in measurement. The day is past when a simple statement of the "reliability" and "validity" of a test was thought to provide sufficient information as to its effectiveness.

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CHAPTER 8

LANGUAGE DEVELOPMENT

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I. INTRODUCTION

Language is the medium by which higher intellectual processes are revealed. It is the essential means of social communication and is one of the outstanding systems of habits which distinguishes man from the lower animals. Consideration of the vast gap between man and the lower animals gives some insight into the tremendous importance of language in the development of the race, and of the inestimable heritage every normal child has in the mother tongue. Differences in language account for many of the marked contrasts between peoples, and to its absence may be attributed the difference between the intellectual development of the congenitally deaf child and that of the normal child. As K. Bühler (31) states:

> "It is in the main language which is responsible for the formation of concepts and therefore for the reorganization of mental life and the dominance of conceptual knowledge over concrete images."

In considering any developmental process, it is important to study it in detail during the period of its most rapid development. As will be seen, language proper emerges in late infancy; and yet in the course of a short three years the child has a highly developed system of linguistic habits that he uses for the expression of his every need and desire, both physical and intellectual; and, in addition, he is able to use all the most complex forms of sentences with appropriate inflections, and his vocabulary amounts to several thousand words. This astonishingly rapid development of such an elaborate system of symbolic habits in such immature individuals is of peculiar interest to the child psychologist. How this elaborate and intricate system of oral language has been developed in these early years is the aspect of the language problem upon which the present discussion is intended to throw some light. No attempt is made here to cover the fields of philology, phonetics, or speech pathology; the emphasis is rather on the normal development of language during the preschool period.

II. DESCRIPTION OF LITERATURE

A. Biographical Studies. The great bulk of the literature on language development consists of semi-scientific papers, chiefly biographical and anecdotal in character, which appeared during the wave of interest in the child study movement beginning about 1890.

These investigations, some of which are intended to study language development, and in others of which this aspect is studied only incidentally, fall quite naturally into three distinct groups: (*a*) those concerned with the prelinguistic babblings of infancy, which are few and inadequate; (*b*) the more numerous vocabulary studies that attempt to list all the words used or understood at a given age; and (*c*) those that are concerned with sentence formation and with some of the more complex aspects of language development. While this body of material is stimulating and suggestive, it is of little scientific value, for these isolated observations on single children have been recorded by different methods, the records have been taken under different conditions, and most of them are subject to the unreliability of the parents' reports.

B. Previous Reviews. The literature in this field has been brought together from time to time by various writers whose reviews consist largely of tabulations of the age of the appearance of the first word and the size of vocabularies as reported in the literature. In 1833 Feldman (65) reviewed the reports of the vocabularies of thirty-three children and in 1883 a brief review of foreign studies was given by Sikorski (194). Preyer (172) compares his son's progress in language with that reported by Stumpf (209), Lindner (123), Sigismund (193), and others. Sanford (183) also gave a very incomplete summary of the work previous to 1891. Tracy (219) in 1893 presented an excellent summary of the studies of children's language up to two years of age. Meumann (140) discusses the early anecdotal accounts in the foreign literature, particularly those of Ament (4), Lindner (123), Gheorgor (79), and others. In 1907 Clara and William Stern (202), in their book called *Children's Speech,* ably summarized the literature up to that time. Between 1907 and 1920 tabular summaries of vocabulary studies were published by Doran (57), Gerlach (75), Grant (86), Magni (129), and Pelsma (163). Bateman (12) summarized all the published reports on the first word prior to 1917, and Doran (57) compiled a summary table of vocabularies of ninety-eight children between eight and seventy-two months of age which were published before 1907.

The Twenty-eighth Yearbook of the National Society for the Study of Education (145) (1929) includes abstracts of 123 published studies on language and of 20 researches in progress. The May, 1929, issue of the *Psychological Bulletin* (2, 168) was a "Special Language Number," but little emphasis was placed on linguistic development in the early years. More recently, McCarthy (136) published a summary of the reports of infants' vocalizations up to and including the appearance of the first word.

The general discussions on language are numerous, and many of them are broad in scope. Among the earlier contributors are Perez (164), Dearborn (48), Chamberlain (34), and MacDougall (128). Allport (3) gives an excellent description of the organs of speech and explains the infant's learning of words on the conditioned-reflex principle. The reader

who is interested in the physical and phonetic aspects of speech is referred to the recent volume by Paget (161). A recent concise account of philological and phonetic aspects is presented by Firth (67). The latest major contribution on neurological and pathological factors in speech is that by Travis (220). It is of interest to note the appearance of two excellent chapters on the psychology of language in a volume entitled *Psychology of the Elementary School Subjects* by Garrison and Garrison (74). O'Shea (160) presents a detailed account of the developmental stages. Stinchfield (206), De Laguna (49), and Pillsbury and Meader (166) all have contributed discussions of the psychology of language. Markey (132), in *The Symbolic Process*, devotes several chapters to reworking and interpreting the reports in the literature on children's language. Recent contributions of especial theoretical interest are those by Ogden and Richards (158) and by Lorimer (126). The latter stresses particularly the basic kinaesthetic and auditory-vocal organization of phonetic activity; and also the process of "nominal integration," or the growth of the significance of words.

It is interesting to note that the past few years have witnessed the appearance of many textbooks on child psychology which attempt to summarize briefly the available material on language development. For some of these shorter and more elementary discussions the reader is referred to the appropriate chapters in the books by Morgan (143), Rand, Sweeny, and Vincent (176), K. Bühler (31), and Curti (43).

C. Quantitative Studies. There have, however, been a number of experimental and observational studies of language which are of greater value than the earlier studies because of their improved methods and larger numbers of subjects.

One of the first attempts to devise a language test was that by Descoeudres (51), who constructed a scale that permitted the calculation of the linguistic ages of children from two to seven years of age. The tests consisted of a series of questions intended to examine the understood vocabulary, as well as a phonetic test and a number of tests of verbal memory.

Another vocabulary test for young children was devised by Smith (197) in which test words secured by sampling the Thorndike (217) word list were elicited by the use of objects, pictures, and questions. The test was used with 273 children ranging from eight months to six years of age. In this study, the conversations of 88 children from two to five years of age recorded during an hour of free play were also analyzed.

A vocabulary test was devised by Van Alstyne (224) which measures understood vocabulary, and in which the child responds only by pointing, using no verbal responses. This is an advantage from some points of view as are also the ease of giving, objectivity of scoring, and its inherent interest to the child. The test has a reliability of .87 and correlates practically perfectly with the Kuhlmann (120) intelligence test. The problem of the development of articulation in young children has recently

been studied in detail by Wellman, Case, Mengert, and Bradbury (227). They tested the accuracy of sound production by recording in phonetic symbols the words given by 204 children from two to six years in response to questions regarding pictures presented in a standard way. One hundred thirty-three sounds were tested.

An interesting contribution to methodology was made by Piaget (165), who analyzed children's language from the point of view of the function of the response in relation to the child's environment. He made a detailed analysis of a large number of responses secured from two children six and one-half years of age. His chief interest was to study the logic and thought processes of the child through his language.

McCarthy (137) recorded fifty consecutive verbal responses from each of 140 children with 20 at each of seven age levels ranging by six-months intervals from eighteen to fifty-four months. Paternal occupation was the criterion of selection used in order to secure a representative sampling. The data so obtained were subjected to four different types of analysis according to (*a*) the length of response, (*b*) the complexity of sentence structure, (*c*) the function of the response, and (*d*) the various parts of speech. Each of these analyses was carried on in relation to age, sex, paternal occupation, mental age, and age of associates.

The same methods employed by McCarthy (137) were used by Day (47) in a study of eighty pairs of twins, so that accurate comparisons of the linguistic development of twins and of singletons were thus obtained. Another recent study of particular interest here is that by Strayer (208), in which the relative influence of maturation and training on language development is studied by the method of co-twin control.

The first of a series of articles on child personality by Rugg, Krueger, and Sondergaard (181) is concerned with the language of kindergarten children. In this study twenty-seven children were observed during three fifteen-minute periods, each of which was during a different activity in the nursery-school routine. In this way 3125 remarks were recorded in twenty and one-fourth hours of observation and were analyzed according to a classification based on the functions of the response similar to that of Piaget (165). Shirley (192)[1] also gives an excellent report of an observational study of the beginning of speech in twenty-five infants who were studied at regular intervals for the first two years. Fisher (68)[2] analyzed the records of nine hours of conversation of seventy-two nursery-school children according to function, grammatical structure, and with reference to certain "social indices." Adams (1) also gives functional and structural analyses of the conversations of thirty-nine children taken during 286 hours of observation in a nursery-school free-play situation.

D. Language in Intelligence Testing. Because of the decidedly ver-

[1]Chap. 4, *The Beginnings of Speech,* reported from manuscript through the courtesy of the author.

[2]Reported from manuscript by courtesy of Committee on Higher Degrees, Teachers College, Columbia University.

bal nature of most intelligence tests, and because of their emphasis on extent of vocabulary, considerable material is afforded from the field of mental tests. Terman (215) regards the vocabulary test as the best single measure of intelligence, since it correlates more highly with the Stanford-Binet scale as a whole than any other single test. The testing program has afforded considerable information on the growth of vocabulary in the upper ages, indicating that the vocabulary continues to increase in size at least until mental maturity.

Most tests of general intelligence, both individual and group, are predominantly verbal in character, depending, for the most part, on comprehension of written or oral instructions, and usually requiring verbal or written responses. Not only at the upper ages, and with children of school age, is there such emphasis on language, but in all attempts to measure intelligence, even at the infant level, items of this sort appear. The Merrill-Palmer (210) scale, which was originally intended to be a performance series, includes in its final form thirteen items of a verbal nature. The authors of the Minnesota Intelligence Test for Preschool Children (83), recognizing the importance of this problem, provide separate norms for verbal and non-verbal items as well as the score on the whole battery. The whole problem of the language factors in intelligence tests at higher ages has been thoroughly discussed by Seago (185). The data from the field of mental tests are of value in the study of language development chiefly because of the large samplings to which the tests have been given, and analyses of the verbal items in available test material should prove a decided contribution.

III. Developmental Stages

Despite wide discrepancies in reports as to the age of appearance of various elements in the development of language, as well as differences of opinion as to their significance, it seems apparent that a certain definite sequence can be traced at least for the broader aspects of the developmental process. In brief, it appears that all children begin to use the organs of speech shortly after birth in some simple fundamental utterances usually of a vowel character. Modifications of these sounds then begin to appear with the addition of some of the consonant sounds, and these increase, both in number and variety, during what might be called a period of syllabic utterances. The vocalization then seems to take on a playful character, in which the child merely exercises his newly acquired vocal accomplishments. This stage then develops into a babbling of a rather social nature, what the Germans aptly call "lallen." Imitation becomes an important factor in the selection of the sounds to be practiced, the sounds are uttered with increasingly varied inflections and are accompanied by gestures so that meanings are crudely conveyed. The language of others begins to be understood, although true language has not as yet appeared. It is but a step, however, from this stage of incomprehensible vocalization, accompanied by inflection and gesture, to the appearance of

the first comprehensible word. Other words are added, slowly at first, and single-word utterances suffice for sometime. The vocabulary increases more rapidly as words begin to be combined and the child becomes interested in learning the names of objects in his environment. Incomprehensible utterances decrease, and more of the speech becomes comprehensible. As soon as an elemental vocabulary has been attained, these words are combined into short phrases and sentences which continue to increase in length and complexity as the child grows older. Bean (13) traces the series as follows: vowels alone, consonants in syllables, series of syllables, rhemes (one-word sentences), words, phrases, declarative sentences, and interrogative sentences.

Shirley (192), who is the first to make a longitudinal study of any number of infants from birth until after the emergence of true speech, notes the following sequences: (*a*) vocal grunts of a reflex character, (*b*) syllabic vocalization or vocal play, (*c*) socialized vocalization such as babbling to a person and shouting for attention, (*d*) expressive tones and inflections, (*e*) comprehensible words, (*f*) use of pronouns, (*g*) use of phrases and sentences. With regard to this sequence she states:

> "Marked individual differences were shown in the amount of vocalization, and in the ages at which comprehensible speech began. Nevertheless there was considerable consistency in the sequence. With all the babies grunting and playful babbling preceded social vocalization; and inflection and intonation preceded the use of comprehensible words; pronouns were not acquired until long after the 'first word.' Combination of words into phrases and sentences appeared late in the second year. . . . There is a consistent underlying course in progress toward speech."

Some writers maintain that the exercise of the vocal organs in vocal play is just as instinctive as the random movements of the gross muscles of the body. Gesell (76) presents the results of a complete twenty-four-hour record of the vocal activities of a six-months-old child who spent 3 per cent of its waking time in some form of speech or language activity. At nine months, this same child expended 6.66 per cent of its waking time in such activity. He also presents the frequency of the various sounds used by this child during one day at six months of age. "There were 104 separate moments of vocalization during the day, varying in complexity from one-letter sounds to 32 repeated syllables; 75 sounds and combinations of sounds were used."

With reference to the amount of vocalization during infancy, Shirley (192) states:

> "The curves for both *all* and *different* utterances show a gradual upward trend from birth through the first year. In the second year the curves mount upward at a more rapid rate until at 102 weeks the average number of utterances during the examination is close to thirty. The curve for different utterances lags far behind that for all utterances at every age. Throughout the entire two years the

babies had a marked tendency to repeat the same syllables, the same words, and even the same sentences many times during the examination."

A. Prelinguistic Utterances

1. *The birth-cry.* One of the first responses of the newborn infant is a vocal one, namely, the birth-cry. According to the Blantons (19), it is merely a reflex without any emotional or intellectual meaning; it supplies the blood with fresh oxygen, and is the result of the air being pulled rapidly over the vocal cords. The birth-cry is of interest in the study of language development since it is the first utilization of the intricate organs of speech.

On the basis of her observational study of twenty-five infants, Shirley (192) states:

> "The earliest vocal sound to be recorded was usually described as a grunt. It was uttered in voice tones and probably consisted of a rudimentary vowel, such as *u* or broad *a* finished by an *ng*. . . . Some vocalization other than crying was noted in practically all of the babies during the hospital period, and the median age for the development of the grunt was six days."[3]

2. *Later incomprehensible vocalization.* Other cries of the first few weeks have been variously interpreted and have been thought to be differentiated according to cause. O'Shea (160) states that the early vocal expression is reflex, and for the first two weeks is an undifferentiated squall probably expressive of some form of discomfort. Between the second and fifth weeks he reports that the primitive squall begins to be differentiated to denote special forms of discomfort, and from this point differentiation progresses rapidly, so that soon all the child's vital experience may be revealed in specialized ways.

Bean (13), who has presented one of the most careful and one of the most recent biographical studies on the speech development of a congenitally blind child who regained sight during the acquisition of language, agrees with Shirley (192) and O'Shea (160) in the description of the first sounds, but attaches more significance to them at an early age. He holds that nineteen of L's sounds and combinations of sounds were linked each with its large group of similar situations from the time of its first appearance. He states that several of these connections were clearly evident within a few hours and even a few minutes after birth, a *uaa uaa* accompanied hunger, fatigue, and all other uncomfortable situations and *aeee* coincided with unquestionable causes of pain. He also reports that reliefs and satisfactions were not accompanied by sounds until two and one-half months when long *oo* and short *u* sounds were heard when wants had just been satisfied.

Fenton (66), however, has expressed the opinion that "during this early period sounds are reflex in character,—they are uttered without in-

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[3]In considering all figures reported by Shirley it should be remembered that her group of children was quite highly selected.

tent, and are not to be thought of as indicating particular meanings. Variations in sound are more often indicative of differences in intensity than anything else." This view is supported by Blanton (18), who studied the vocal sounds of twenty-five infants during the first month. She says, "There were differences of vowels and consonants, of timbre and degree, but no one was used as response to one set of circumstances that was not at the same time used to others—the cry of colic was the one exception." She states further that "during the first months of life, the cries of the infant are in response to hunger and pain and cold, and differ from each other only in intensity."

The babbling stage is of particular importance in that it provides practice in the use of the speech mechanism, and it is probable that all the sounds needed in true speech are learned during this period. This period, however, presents to the experimentalist many difficulties which have been discussed by McCarthy (136) in *The Vocalization of Infants, Part II.* There is first the problem of hearing correctly the fleeting meaningless sounds, and then of using accurately any phonetic notation with which to record them. Neither has a satisfactory method of securing a graphic record of infants' vocalizations been devised. Consequently, the various observational reports, so far available, are crude and inconclusive. O'Shea (160), Tracy (219), Blanton (18), Shirley (192), Bean (13), Preyer (171), and Taine (213) agree that the first utterances are vowels of some sort, usually some modification of *a* or of *u*. Several writers attempt to list the various sounds in the order of their appearance. The next stage generally reported involves the appearance of some consonants in combination with the vowels in single syllabic utterances. The *m* sound in the initial position is reported as the first consonant by O'Shea, Blanton, and Bean, and it is listed by Tracy among the first three. The early, and almost universal, appearance of the *m* sound in combination with a vowel has been considered by some theorists to account for the development of the word *mama* and for similar words for "mother" in a number of languages. Tracy and O'Shea agree in giving precedence to the three labials *m, p,* and *b*. This type of syllabic utterance, such as *ma, ba, goo, boo, hauh, aah,* seems to be characteristic of the third month, although Shirley notes the median age for the appearance of the first syllable at eight weeks and Blanton lists eight consonants noted during the first month. Guttural sounds, particularly variations of *g* or *k,* and sounds described as "gurgles" or "sputters" are noted about this time by Tracy, Fenton (66), Bean, and Shirley. Blanton also noted *g* as one of the consonants as early as the first month. Sounds on which authors seem to disagree are *r* and *l,* which Tracy noted were usually late in appearance, though he admits some children may use them early. The former, Blanton noted in two positions during the first month, and Shirley cites illustrations of early syllabic vocalization including the recurrence of both. Fenton reports the late appearance of *f, v,* and *cu* sounds, whereas Shirley notes the *v* sound among the early syllables. Blanton, Bean, Fenton, and

Shirley all report *h* either as a final or initial sound, or in combination with another consonant among the earliest sounds. During this period, Fenton and Bean both report the utterance of German umlaut and guttural sounds as well as certain French vowels and trills. Bean and Shirley both use the same descriptive terms in speaking of the infant's utterances at this stage, agreeing that the period is characterized by a variety of "grunts," "clicks," and "gurgles."

Following closely upon the single syllabic vocalization, Shirley notes:

> "The next improvement in syllabic speech came when the baby repeated the same syllable several times in succession. Such conversations consisted of *uggle-uggle, erdah-erdah, oddle-oddle, a-bah-bah, hey-hey, bup-bup-bup, aduh-duhdeh-duhde-ooh, adhu-ajuh, awooh-awah,* and *lul-lul-lah.* Speech of this sort occurred from five months on. During this stage there was little variety in the baby's babbling. Each baby had one or two characteristic phrases of this sort to which he limited himself for an entire examination; indeed some kept to the same syllables for three or four successive weeks."

Again, she says, "although consonant sounds in combination with vowels appeared very early, there was a later age at which the babies seemed to single out one or two consonants for practice." This observation apparently coincides with that of Bean who reports that after the first few consonants were noticed, the remaining ones followed in slow succession and that "when a consonant put in its appearance it reappeared almost hourly."

Moore (142) reports that her child used all the sounds in the language by the fourth month, Fenton noted all but three, but with a great variety of additional sounds that could not be spelled in our alphabet. Bean and Shirley also report tremendous variety in the later babbling stages which defied notation in many instances. Shirley adds:

> "At about 10 or 11 months the babies injected greater variety into their speech by combining two or more dissimilar syllables which made their speech take on conversational form. . . . Later the babies jabbered in sentences combining several incomprehensible words and uttering them with assertive, interrogative, and exclamatory inflection. . . . Such conversational jargon was carried over and mixed in with early comprehensible speech. . . . Late in the first year . . . syllabic speech began to increase, and throughout the second year it climbed consistently. From 70 to 86 weeks its progress was averted and at 90 weeks it began definitely to fall off; comprehensible speech had begun to take its place."

In the study by McCarthy (137), it was found that only 26 per cent of the vocal responses of twenty children eighteen months of age were comprehensible. The incomprehensible speech dropped out rapidly thereafter, as shown by the facts that 89 per cent was comprehensible at thirty months and 99.6 per cent at forty-eight months. Comprehensibility of children's speech is determined at least in part by accuracy of articula-

tion. Details of the developmental trends in this aspect are presented by Wellman, Case, Mengert, and Bradbury (227). Fisher (68) also found that the amount of non-verbal speech decreases rapidly with advance in age up to the beginning of the fourth year. She reports a correlation of —.42 between chronological age and percentage of non-verbal speech. Among older children its persistence tends to be associated with dramatic play, while among the younger it is often a substitute for speech forms which are still under control. With regard to the social nature of the babbling stage, Shirley (192) states:

> "Somewhere between 2 and 6 months speech became a social reaction. The babies definitely babbled to the examiners at a median age of 25 weeks."

This again is in close agreement with Bean (13) who says:

> "The desire for social approval is the strongest inducement for a baby to repeat a sound until it becomes a part of his permanent repertoire. Children try to attract attention even before the middle of the first year."

In summary, with regard to this prelinguistic period, it appears that the earlier observations on single children, whether because of bias on the part of the observers or not, seem to be largely in accord with the traditional theories of learning, the complex being derived from the simple until sufficient raw material of vocalization was learned to enable the child to proceed with what Major (130) calls "the building proper" of language. More recent and more objective observers and reports based on larger numbers of children tend to show that there is a wide variety in the babbling repertoire at a fairly early age, due to the plasticity of the youthful organs of speech, and that only those sounds that appear in the mother tongue are selected through use and survive as needed elements in the permanent vocal repertoire. The latter theory is supported by the facts that infants are reported to make many sounds that do not appear in any single language and that any child, regardless of his parentage, learns the language that he hears spoken about him. This theory is called into question by the frequency of infantile speech in even older children after the emergence of true language. This objection is met, however, by Bean (13), who holds that children's mispronunciations are due to crude perception rather than to inability to pronounce the elemental sounds. Incomprehensible vocalization disappears rapidly during the third year, although examples of it may be found at least throughout the preschool period.

B. Imitation, Training, and Maturation. Most observers of child development report a tendency to imitation in all functions and that this tendency is readily observed in the reproduction of vocal sounds. Many writers regard this imitative tendency as the most important single factor in the acquisition of language by the child. The facts that the congenitally deaf child fails to learn to talk and that the normal child learns what-

ever language he hears bear witness to the justifiability of such emphasis. To mention a few of the actual observations reported: Champneys (35) states, "From nine months the child distinctly imitated the intonation of the voice when any word or sentence was repeated in the same way several times"; Pollock (167) says, in speaking of the seventeenth and eighteenth months, "The vocabulary is now increasing fast and almost any word proposed to the child is imitated with some real effort at correctness"; Whipple and Whipple (228) report that at about nine months imitation became very active; Hall (92) recorded in the diary of her son on the two-hundred-and-twenty-first day, "Very early in the imitative stage the lip movements accompanying such words as mama, papa, and bye-bye were repeated," and on the two-hundred-and-twenty-third day, "in response to a lady's farewell he imitated both the gesture and the word."

It is necessary in this connection to distinguish between two different types of behavior to which the term "imitation" is often applied. The first, and more limited use of the term, refers only to exact reproductions of actions or sounds performed before the child. While this mimetic type of reproduction probably does occur in some instances, it is much more rare than the second type of imitation by which is meant the attempt to reproduce regardless of the accuracy or success of the accomplishment. This latter tendency is characteristic of the young child in the last months of the first year and the first months of the second year and is readily observed in the field of vocalization. Most psychologists seem to agree with the opinion of Taine (213), expressed as early as 1877, that new sounds are not learned by imitation, but rather that the child imitates only the sounds which have already occurred in its spontaneous babblings, and that the imitation of the speech of others serves only to call attention to new combinations of the sounds already used. In speaking of his daughter, he says:

> "Example and education were only of use in calling her attention to the sounds that she had already found out for herself—but all initiative belongs to her."

As Curti (43) says:

> "By repeating to the child other sounds which he has already spontaneously practiced, adults may evoke the sounds again and again and thus lead to facility in their use. No sound, however, will be thus repeated which the child has not already used."

Pillsbury and Meader (166), in discussing this problem, state:

> "It has been suggested by many authorities that imitation furnishes the real explanation of learning to talk, but when carefully studied it will be seen that there is really no separate and specific impulse to imitate. . . . Imitation is not indiscriminate in the first place, and when one looks to the processes that control it one finds that it is made up of two parts. The first is the tendency to be interested in

any movement that it has frequently seen made by others or any word spoken by others, and to repeat any movement that attracts attention and holds it. Choice and instincts supply these movements."

With regard to this matter of imitation Shirley (192) concludes:

"Undoubtedly much is contributed to the development of the baby's speech through conscious training on the part of parents and spontaneous experiment and imitative practice on the baby's part. Yet there is a consistent underlying course in progress toward speech which would seem to argue that vocal expression has an instinctive basis and is not free from the trammels of maturation."

She also notes the significant tendency to imitate intonations and inflections regardless of the specific sounds, and remarks,

"After all, it is the expressive element which makes speech important, and not the actual words in which it is cloaked. It is impossible to say from this study whether the expressive tones were a normal outgrowth of development or whether they were acquired through imitation of adults; the writer, however, holds to the former theory."

Training experiments in language presuppose imitation as a basic factor. One of the most conclusive experiments on this point is that by Strayer (208) in which one member of a pair of identical twins was given intensive training in naming objects, etc., for a period of five weeks, while the other twin was deprived of all opportunity to hear language during that period. After this initial experimental period, similar training was given the other twin. The author concludes:

"A maturational difference of even five weeks has a definite influence on the relative effectiveness of training. . . . Not only was training which was begun with a maturational advantage of five weeks more effective than earlier training, but the pattern of response was more mature. Training cannot transcend maturational level as evidenced by the fact that intensive training failed to bring either retarded child up to average in the particular function though it is effective to some degree in improving vocabulary."

She adds that the typical stages in the learning process were strikingly alike for both children. A similar tendency can be noted at a higher age level in the study by Sommer (201) in which the effect of group training on the correction of articulatory defects was studied in nursery-school and kindergarten children by the method of paired controls. The experimental group improved 57 per cent while the control group showed an improvement of 28 per cent. While the difference is in favor of the experimental group, the 28-per-cent improvement in the control group would tend to substantiate the evidence cited above in favor of a maturational influence.

C. Language Comprehension. The early biographical studies are replete with anecdotal accounts as evidence that children understand the language of others long before they use true language. This fact seems to be generally recognized and is borne out in adult language by the com-

mon observation that the vocabulary of words understood by an individual is much larger than the vocabulary in active use. However, the information as to the age at which spoken language first has meaning for the child is strongly colored by the unreliability of parents' reports, and the incidents vary greatly, not only in the circumstances surrounding them, but also in the ages of the children at the time of their occurrence.

Bean (13) reports that long before his child could pronounce a word he knew the meanings of a great many words. As a training method, he attempted to converse with him in single words or short phrases at this period and secured three repetitions for each item as evidence that "association links" had been formed between 152 words and phrases and the objects or acts to which they belonged.

Attempts have been made recently to recognize this factor of language comprehension in experimental studies. Gesell (76), for example, includes in his normative series such items as "adjusts to words," "points to pictures," "obeys prepositions," etc., and the vocabulary tests of Van Alstyne (224) and of Smith (197) also attempt to measure the child's understood vocabulary, and not merely the words actually elicited in a test situation.

D. The First Word. Following closely upon the imitative stage, and often overlapping it, the child uses his first word. This is the important step which represents the emergence of true language from the chaos of his early babblings. When the child first uses a sound with meaning, i.e., as a word, is difficult to determine. This event is so eagerly awaited by parents that frequently they attach meaning to some of the child's most frequent utterances that chance to coincide with the appearance of certain objects or persons, but which originally had no meaning to the child.

Lorimer (126) points out that "because of the variety of factors involved in the origin of words it is rather artificial to attempt ever to say exactly what is the child's 'first word.'" He adds that some parents apply this term to the first word repeated, i.e., vocal imitation; whereas others apply it to the first word "understood" or to the first word "spoken."

The literature is replete with discussions (Allport, 3; Curti, 43; Barnes, 8; *et al.*) showing how attachments are made between sounds produced by the child or by others, and the particular objects or events for which they stand, that is, how verbal symbols acquire meaning. For example, Curti states:

> "When the baby articulates a given syllable . . . he is being stimulated by two main groups of stimuli, one the auditory group . . . the other a kinaesthetic-tactual group. . . . With a few chance repetitions of the sound, we have the essentials for the formation of conditional response, namely two stimuli affecting the organism at the same time. . . . The infant having been so conditioned by his spontaneous 'practice' that the auditory stimulus of a sound alone is

> sufficient to produce the response of making the sound, the next step is clear—that is the evoking of the sound by the auditory stimulus *given by others*."

In Bateman's (12) paper on the first word, the most frequent occurrence of the first word was found to be at ten months of age. He reports that 74 per cent of the children observed had begun articulate speech by the end of the first year.

Shirley (192) gives the median age at which the first comprehensible word was spoken in the examiners' presence as sixty weeks. "Most of the mothers," she states, "reported that the babies had a vocabulary of two or three words at one year." The earliest utterance of a meaningful word in the examiners' presence was a thirty-seven weeks.

> "From then on to the end of the first year a few words were spoken at each age. At 54 weeks the babies averaged two comprehensible words each; at 66 weeks the number increased to seven."

In Smith's (197) study none of the thirteen children studied at eight months of age had begun to talk. The seventeen children at ten months had an average vocabulary of one word, and fifty-two at one year of age had an average vocabulary of three words. (See Table 1.)

From the earlier literature it appears that the first word is usually a name of a familiar object or person and consists of a monosyllable or a reduplicated monosyllable, although interjections also appear very early. According to Shirley (192):

> "Many, but not all of the 'first words' heard by the examiners were nouns. *Mama* was the first word of five babies, and *baby, there,* and *see* each were given first by two babies. Nouns, verbs, adjectives and adverbs occurred as 'first words.'"

TABLE 1

INCREASE IN SIZE OF VOCABULARY IN RELATION TO AGE

From Smith (197)

Age group		No. of	Av.	Vocabulary	
Years	Months	children	IQ	No. of words	Gain
	8	13		0	
	10	17		1	1
1	0	52		3	2
1	3	19		19	16
1	6	14		22	3
1	9	14		118	96
2	0	25		272	154
2	6	14		446	174
3	0	20	109	896	450
3	6	26	106	1222	326
4	0	26	109	1540	318
4	6	32	109	1870	330
5	0	20	108	2072	202
5	6	27	110	2289	217
6	0	9	108	2562	273

Perez (164) says that in the language of children the roots or first attempts are monosyllabic sounds. "They more easily pronounce reduplicated monosyllables. For a long time they rebel against real dissyllables and still longer against polysyllables." Hall (92) states that the first six words articulated by her son were words in which the syllable was doubled as in *bye-bye*. It is frequently pointed out how easily favorite syllables, when doubled, come to designate familiar persons and objects, and hence the familiar appellations of babyhood, *mama, papa, dada, bebe, bye-bye,* and the like. Kroeber (119) reports the same tendency noted in the speech of a Zuni child, who, by his second birthday "was drifting away from his early leaning to make every word consist of two identical but separate syllables." In this connection Stern (203) also points out the "tendency to use such words as show a natural connection between sound and meaning," such as *bow-wow, moo-moo, tick-tick,* and the like. Shirley (192) calls these "childish imitative words" and notes that "some babies used these words a great deal, and others seldom. Apparently," she states, "they were picked up from the parents or older children in most cases rather than invented by the babies themselves."

E. The Single-Word Sentence. Children understand and use gestures long before they understand words. Many children develop this gesture language to such a degree that it serves their purposes sufficiently well for a considerable period, and they feel no need of developing a verbal expression. Thus gesture language habits often hinder the development of vocal language habits.

However, the early emotional connotations of the various cries and intonations of the voice in the early babble stage, together with the gesture language, add a great deal to the diversity and usefulness of the child's expression when he begins to speak in single words. By means of inflection and gesture the child often facilitates his single-worded expression so that complete thoughts are conveyed. Recognition of this fact is apparent in the literature from the frequent occurrence of such terms as the "sentence-word" and the "single-word sentence." Bean (13) terms this type of response the "rheme." Many of the early utterances can be clearly detected as imperative in tone or perhaps exclamatory in function, and the questioning inflection is quite unmistakable even in the early monosyllabic sounds. Koffka (118) speaks of "words spoken as one-word sentences with a wish or affective character." The single word *mama* may mean "mama give me," "mama look," or "there is mama," according to the inflection with which it is uttered and the gestures that accompany it. Stern (203) states:

> "The child's first utterances are not words in the real sense of the word, but *whole sentences;* for the novice in speech does not talk to express concepts as such, but rather his own attitude to them. This is the only explanation of the fact that one and the same speech-unit can be used with such multitudinous meanings. . . . Gestures, intonation and the situation as a whole all help to lend the necessary shade

of meaning to the short utterance with its possibility of many meanings."

Pelsma (163) comments, "The first expressions of the child should be called sentence-words rather than 'parts of speech.' It is the whole of speech." Lukens (127) effectively expresses the same point of view when he says, "Such words are undifferentiated sentence-words, and are similar to such exclamations as 'Fire!' 'Thief!' There is no grammar to such expressions, since grammar has to do with the relation of different words to each other, and here there is only one word." Miss Sullivan, in writing of Helen Keller's (113) early language, says, "Like her baby cousin, she expresses whole sentences by single words." Bean (13) reports that his child first used single words to express each unit of experience. He considers that the one-word sentence, or "rheme," is characteristic of this stage of the child's thought at this time.

IV. The Growth of Vocabulary

A. Extent of Vocabularies. Studies of vocabularies may be classed into two major groups: first, those which attempt a quantitative enumeration or estimate of the extent of total vocabulary; and, secondly, those which attempt a qualitative analysis of vocabularies according to the various parts of speech; the latter may be based either on total vocabularies or on samples of conversation. In general, there appear such serious discrepancies of method, as different lengths of observation periods and different criteria for the inclusion of words, that it is almost impossible to manipulate the results of these early biographical studies so as to obtain any adequate comparisons. Summaries have been attempted by Doran (57), Waddle (225), Horn (100), and others. Outstanding among the individual vocabularies recorded are those by Boyd (24), Deville (53), the Whipples (228), the Gales (72), Bateman (9), the Brandenburgs (28), Haggerty (89), and Nice (146, 154). Attempts at complete enumeration have been confined chiefly to the preschool period, whereas various techniques of sampling by some modification of the free-association method, or of requiring definitions of certain samplings from compiled word lists, have been used for estimating extent of vocabulary at higher ages, particularly at the elementary-school level.

According to the Smith (197) study, which is the most extensive at the preschool level, the vocabulary increased from 0 at eight months to 2562 words at six years; the average gain per year from two to six years being 472.5 words. The table showing the increase from year to year is given above. (See Table 1.)

It appears from several sources that the growth of vocabulary is characterized by a slow initial increase followed by rapid improvement. Nice (151) reports a case in which the first two words acquired at sixteen months sufficed for four months, and, after a series of careful observations on other cases, she subdivided the period of single words into an early one of slow growth, followed by a second period of rapid acquisition

of words. In the study by Shirley (192) it is reported that "individual differences in the size of vocabularies used at the examination were great. On the average each baby had spoken 36.9 different words in the examiners' presence by the age of two years; the range, however, was from 6 to 126 words. Only 274 different words were used by the entire group." In spite of the fact that this was a highly selected group, the vocabularies are smaller than those given by Smith (197). This can probably be accounted for by the fact that Shirley's figures were based on words actually spoken, whereas Smith's testing technique permitted indirect evidence of knowledge of a word.

McCarthy (137) found that the mean number of words used in a sampling of 50 responses from each of 140 children increased steadily with age from 20.3 at eighteen months to 230.5 at fifty-four months. The mean number of different words used was also found to increase over this age range from 10.0 to 99.5. A similar trend is reported by Day (47). Blachly (17) reports that 51 children eighteen months of age had an average vocabulary of 69 words. Descoeudres (51) used a series of questions in order to determine the extent of understood vocabulary. Partial tests consisting of the items of greatest diagnostic value were given to from 290 to 330 subjects ranging in age from two to seven years. Her figures all run considerably higher than those of Smith (197), probably because in this study the test conditions were less rigorous. The Van Alstyne (224) vocabulary test provides norms for three-year-olds on a test involving pointing to the correct picture, out of four on a card, in response to verbal commands. The average vocabulary comprehension thus obtained was 975 words.

These differences in method immediately bring up the question raised by Dale (44), namely, what do we mean when we say that a child "knows" a word? This author goes on to point out that "know" is a relative term, since there are accretions to the meanings of words throughout life, and that "knowing" should be defined in terms of specific reactions one is able to make to a word.

Studies by Prescott (169) and by Dolch (55) at the elementary-school level used a fifteen-minute free-association test on large numbers of children. The former study shows an increase in the average number of words given from 35 at seven years to 157 at thirteen years, while the latter shows a steady increase from 73 words for the average second-grade child to 191 in the eighth grade. Numerous unpublished vocabulary estimates at the elementary-school level are listed and annotated in the *Bibliography of Research Studies in Education* published annually by the United States Office of Education (223).

There is ample evidence to indicate that the vocabulary continues to increase at least until mental maturity. While it is impossible to obtain accurate vocabulary counts at higher ages, a number of estimates have been made which tend to agree fairly well. Markey (132) cites tables of estimates given by Kirkpatrick (117) and by Brandenburg (27) which

indicate that the average senior in high school has a vocabulary of between 15,000 and 18,000 words. The figures given by Terman (215) on the basis of the vocabulary test in the Stanford-Binet individual examination are somewhat lower but indicate practically a linear relationship between chronological age and increase in vocabulary.

B. Parts of Speech in Vocabularies. In addition to a quantitative analysis of the extent of vocabulary, most of these studies also give a qualitative analysis of the vocabulary, grouping the words according to parts of speech. A striking characteristic reported quite consistently is the preponderance of nouns (50 to 60 per cent) at the two-year level. This is coincident with the period immediately following the all-important discovery that everything has a name, a period which is often termed the naming stage by such writers as Koffka (118), Keller (113), Bean (13), and others. Grant (86), who has made an extensive survey of published vocabularies, states: "Most vocabularies are made up of even more than 50 per cent nouns. In general, the proportion of nouns to the entire vocabulary decreases as the vocabulary increases, and the proportion of verbs increases accordingly."

Such a large proportion of the young child's vocabulary is reported to be interjectional in character that some writers have postulated the interjectional theory of the origin of language. This preponderance of interjectional speech at the younger ages, the early use of many nouns, and a relatively large verbal element were outstanding in the studies summarized by Waddle (225). Personal pronouns, relative pronouns, and subordinating and connecting words were found to be acquired late and with difficulty. Markey (132) emphasizes the "action content" or verbal function of many of the children's early words. He devotes two chapters to the development of the use of personal pronouns, indicating that at first symbolic development is centered around the self and later extends to include others.

The whole process of classifying child vocabularies into the categories of the various parts of speech, however, is rather questionable. As pointed out, the one word used is frequently a name, and hence it is classed as a noun. Yet most writers recognize that this so-called noun has the function of a whole sentence. Lukens (127) emphasizes this difficulty, for he says, "To classify such child-words by the adult distinctions of the parts of speech . . . is of course to be misled by very superficial considerations. It does not seem possible to classify a child's words until he uses all of the parts of speech." It thus appears that almost any word may in the child's usage function as any part of speech which is needed in the situation regardless of its usual classification. As Dewey (54) says, "The psychological classification is to class the word according to what it means to a child, not to the adult with his grammatical forms all differentiated."

C. Parts of Speech in Conversation. There are, in addition to the studies cited above, a number of studies that are concerned with the extent of vocabulary as it is exhibited in the child's conversation. Some studies in

which the all-day conversation method was employed have been analyzed according to the frequency of the various parts of speech. Such data lend themselves much more readily to a functional classification of words as they are used than to mere classification of isolated words. The proportions of the various parts of speech that it is possible to know are determined by the proportions of each in the language, and this factor makes for a preponderance of nouns in any adult's vocabulary. However, the mechanism of sentence formation is such that only a small proportion of the fund of known nouns is actually needed and put into active use in conversation. Thus, there are two possible methods of classifying vocabularies, the one using the total number of words used, and the other the number of different words used. Zyve (236), who recorded the conversations of third-grade children during a fifteen-minute story period for about three months, used both these methods of tabulation and obtained strikingly different results. The nouns are 51 per cent of the number of different words used, and only 15 per cent of the total number of words. Verbs represent 22 per cent of the number of different words used, and they increase to 27 per cent of the total number of words. The pronouns also show a striking difference when tabulated according to the two different methods, as they equal only 1.5 per cent of the number of different words and 17.2 per cent of the total number of words used. Like the nouns, the adjectives show a decrease, but the adverbs, prepositions, and conjunctions all show relative increases when considered according to the total number of words used. One of the striking artificialities of the method based on the variety of words is illustrated by Zyve's figures on the articles. There are only three different articles in the English language; all three of them are used by very young children, yet they represent only .1 per cent of the number of different words. These words, however, are important in conversation and represent 7 per cent of the total number of words used.

McCarthy (137) and Day (47) both made word analyses using both methods of tabulation. These studies, as well as Smith's (197) which is based on a number of representative children at several discrete age levels, yield more reliable age trends than previous studies. All three studies show comparable proportions of frequencies and similar age trends. What differences appear can probably be accounted for on the basis of differences in age groupings, the different situations in which the records were made, or selective factors such as twinning.

The most notable trends shown in analyses according to total number of words used, and which maintain, though to a lesser degree, in analyses based on number of different words, are a marked decrease in the percentage of nouns and interjections, and a corresponding increase in the percentages of verbs, adverbs, adjectives, and pronouns. Conjunctions and prepositions appear late and increase only slightly in relative numbers. Nice (156) found that the proportions of the various parts of speech in the lists of both total words and most frequently used words

were in striking agreement. The proportions among the number of different words, however, were found to be less significant. Comparing the conversation of older children from three to ten years with that of a thirty-months-old child in the proportions of different words used, she finds a relative decrease in nouns, adjectives, and exclamations and a decided increase in verbs, pronouns, prepositions, and conjunctions. Adults' conversations in this study include relatively more nouns and prepositions and fewer pronouns and adjectives than conversations of children in the established-sentence stage. The author further reports that in all but one of the conversations studied verbs lead in numbers and that adult conversation differs little from that of older children except in an increase in prepositions and conjunctions and a slight decrease in pronouns.

An interesting subjective summary of qualitative changes in vocabulary is given by this author, who states that the words of the baby are vivid and show egotism, desire, and dependence on the parents, whereas older children approximate the comparatively colorless speech of the adult. There is a decrease in the use of self-words. Words of the older children are reported to be much less concrete and vivid than those of the little ones. Instead of nouns, they learn to use pronouns; and instead of gestures, prepositions are used. Nice (156) says that there is less emotional and more intellectual content as speech develops, and that what is lost in picturesqueness is gained in clarity.

Bean (13) states that children do not use pronouns until they are well used to nouns. In substantiation of this, Shirley (192) reports that pronouns did not appear until late in the second year, the median age for the appearance of this item in her group being ninety-nine weeks. Bean further notes that adjectives are not used extensively until nouns are numerous, and that adverbs are added much more slowly than adjectives. They are not added, he asserts, until a fair degree of familiarity with verbs has been attained.

Another type of study of the child's vocabulary that has received considerable attention has been the compilation of word lists based on running conversations of young children. The most active investigators in this field are E. and M. D. Horn (100-102), who have published a series of articles giving such tabulations as the 1003 most common words used by children from one to six years of age and a list of 2500 words in the vocabularies of normal children before entering first grade. Most vocabulary studies at the elementary-school level use this list and *The Teachers' Word Book* by Thorndike (217) as standard check lists. The latter is based on frequencies of words occurring in children's textbooks.

V. The Development of the Sentence

A. Length of Response. Following closely upon the appearance of the first word and the single-word sentence, and coinciding with the period

of rapid growth of vocabulary, word combinations begin to appear in increasing complexity.

The simplest and most objective measure of sentence formation, or the degree to which children combine words, is the mean length of response. This measure is advocated by Nice (153) who considers it a particularly significant index of the child's stage of linguistic development. Smith (197) also found this measure a satisfactory developmental index and states that there is a steady increase in length of response up to four and one-half years with only small gains after three and one-half years. She considers it a significant measure only up to four or four and one-half years.

In the study by McCarthy (137) data were also secured on length of response which yielded an odd-even reliability coefficient of .91 for responses recorded in the same situation. The same trend with age appeared in this study as in the Day (47), Shirley (192), and Fisher (68) studies. Table 2 gives the comparative figures on length of response from these investigations. As might be expected from Fisher's gifted group (mean IQ 132.6), the figures run much higher than in any of the other studies. This group showed continued increase in length of response after four years. Barnard (7), in an analysis of the speeches of Wendell Phillips, found an average length of sentence of 22.98 words, which suggests that this might prove a useful measure even up to the adult level. Fisher, however, on the basis of a correlation of .58 between the mean lengths of the first fifty responses on two successive days, questions the reliability of the measure when based on fifty responses. This is in agreement with the results of another study by McCarthy (135) in which comparisons of lengths of responses secured in different situations revealed a correlation of .54. An observational study by Goodenough (82) on talkativeness also revealed a reliability coefficient of .59. Nice (156), in working over the all-day conversations of her daughter, discovered that an hour's record [the unit used by Smith (197) and by Adams (1)] could serve almost as well as that for the whole day in picturing the child's skill in speech. These results point to the need for caution in the use and interpretation of such criteria and to the importance of giving due considera-

TABLE 2

MEAN NUMBER OF WORDS PER RESPONSE BY CHRONOLOGICAL AGE AND SEX

	Smith study			McCarthy study			Day study			Fisher study		
CA	B.	G.	All	B.	G.	All	B.	G.	All	B.	G.	All
18				1.0	1.3	1.2				3.4	3.9	3.7
24	1.9	2.4	1.7	1.4	2.1	1.8	1.3	1.7	1.5	4.7	4.8	4.8
30			2.4	3.2	3.1	3.1				3.4	5.3	4.7
36	3.5	3.1	3.3	3.1	3.8	3.4	2.5	2.5	2.5	5.0	6.3	5.6
42			4.0	4.2	4.4	4.3				8.4	5.6	6.9
48	3.4	4.5	4.3	4.3	4.4	4.4	3.0	3.0	3.0	6.9	7.6	7.2
54			4.7	4.6	4.7	4.6				10.1	8.3	9.5
60	4.8	4.5	4.6				2.9	3.5	3.2			

tion to the conditions under which the responses are secured. The striking agreement for this measure for groups of children studied by different investigators, as well as the differentiation it shows between groups, however, gives evidence as to its value.

B. Sentence Structure. While the child is acquiring new words rapidly during these first years, he is also beginning to combine the words which he knows in varying degrees of complexity. Following the single-word–sentence stage, which consists chiefly of nouns, is the period characterized by the noun-verb combination. Early writers indicated little interest in the manner in which children combine words and in the complexities of sentence structure. The early biographical studies usually give anecdotal accounts of the first sentence, but make little or no attempt to trace sentence formation further. According to a summary of the biographical studies in the *Twenty-eighth Yearbook of the National Society for the Study of Education* (145), the time of the appearance of the first sentence is reported from the fifteenth to the twenty-sixth month by Bateman (9), Bohn (22), Dearborn (48), Drummond (60), Guillaume (87), Moore (142), Nice (153), and Stern (203). Nice reports the average age of the appearance of the first sentence for twenty children as 17.5 months. Moore, one of the first to give serious mention to sentence formation, says that her son used his first noun-verb combination in his sixty-sixth week. Shirley (192) states that one baby in her group talked in short sentences at sixty-six weeks and that a few children began using phrases and sentences shortly before eighteen months. She calls attention to the perseverative tendency in the first phrases and sentences, and suggests that possibly the variety of sentences used would afford a better measure than the total number of sentences at this stage. Adams (1) also reports a decrease with age in the tendency to repetition. Among the large bulk of biographical studies, some of those which contain analyses of sentence structure are those by Boyd (25), Moore (142), Nice (153), and Pollock (167). Moore noted that the sequences of words in sentences were usually correct, but that there were many omissions. Among 124 sentences used during the ninety-sixth week, 33.8 per cent contained no verb. The same child was observed during the one-hundred-and-second week and of 138 sentences only 7.2 per cent were without verbs. Nice (153, 156) outlines the various stages in sentence formation as follows: (*a*) The single-word stage from four to twelve months. (*b*) The early sentence stage from thirteen to twenty-seven months with an average at seventeen and one-half months, lasting from four to seven months and characterized by a preponderance of nouns, lack of articles, auxiliaries and copulative verbs, prepositions and conjunctions. (*c*) The short-sentence stage which consists of sentences of from 3.5 to 4.5 words in length and having the same characteristics as the preceding stage but to a lesser degree. Inflections are not yet mastered and only one or two sentences out of fifty are compound or complex. There is little data on the duration of this stage. (*d*) The complete-sentence stage which ap-

pears at about four years and consists of sentences of from six to eight words characterized by greater definiteness and complexity as shown by an increased use of relational words. Nice (153) reports that at this stage the inflections have been practically mastered and the majority of sentences are complete. According to Bean (13), sentence building is especially dominant in the early part of the fifth year.

On the basis of her study, Smith (197) concludes that "the most significant trend in the development of the sentence with increase in age was an increasing tendency toward the use of longer and more complete sentences . . . and a decrease with age in the proportion of simple sentences to complex and compound sentences."

The results of McCarthy's (137) analysis according to complexity of sentence structure revealed the following tendencies with age: (*a*) a decrease in the relative numbers of "functionally complete but structurally incomplete responses" (i.e., those which were adequate in the situation according to adult conversational usage); (*b*) an initial increase in the number of simple sentences; (*c*) an increase in the use of simple sentences with phrases; (*d*) later increases in the percentages of compound, complex, and elaborated sentences. Detection of omissions became easier as sentences took on more definite form, so that incomplete sentences showed a marked increase until about three years, and a decrease thereafter.

The studies of Nice (153), Fisher (68), and McCarthy (137) are in close agreement as to the frequency of compound and complex sentences in the later preschool years. Fisher reports correlations of +.73 between chronological age and percentage of complete sentences, —.74 between age and percentage of simple sentences and +.79 between age and percentage of complex sentences. The simple sentences she found most common at all ages, complex and compound sentences constituting 5 and 2 per cent, respectively, of the total number of sentences at the upper preschool level.

Such measures might also prove valuable in studies of comparisons of child and adult speech since Barnard's (7) analysis indicates only 34.9 per cent simple sentences and 8.1 per cent compound, 41.4 per cent complex and 15.7 per cent compound-complex in the speeches of Wendell Phillips.

VI. The Functions of Language

In any attempt to study the child's language as a whole it is essential to consider not only the quantitative aspects, such as extent of vocabulary, length of sentence, and such objective aspects as sentence structure, but also a qualitative approach to the functions of language in the child's life. If language develops in accordance with the child's needs, what needs does he satisfy by the use of verbal responses? In what situations does speech first appear? What kinds of responses are used in these various situations, and what changes do these responses show as the child

grows older? Piaget (165) points out that adults as well as children use language for different purposes.

> "At times, his language serves only to assert, words state objective facts, they convey information, and are closely bound up with cognition. . . . At times, on the other hand, language expresses commands or desires, and serves to criticize or to threaten, in a word to arouse feelings and provoke action."

The old grammatical classification of sentences into declarative, imperative, interrogatory, and exclamatory sentences was a crude attempt at an analysis of language according to its function, which has served fairly well for written language. The problem becomes more complicated, however, when one attempts to apply such a classification to adult conversation, and still more so in the case of the conversation of children.

Snyder (200) attempted to ultilize this grammatical classification by making many subheads and variations of the several groups, and Smith (197), who used the Snyder classification with some modifications, concludes:

> "There are more declarative sentences, at all ages, than any other type. Also the proportion of imperative sentences, including variations, is probably significantly greater than the proportion of questions at two, three, and four years."

Another approach to this aspect of the problem which is less arbitrary was attempted by Piaget (165), who devised a classification of children's responses on a functional basis. This approach has since been used by McCarthy (137), Day (47), Zagorovskii (234), Johnson and Josey (109), and similar ones have been devised by Rugg, Krueger, and Sondergaard (181) and by Adams (1).

According to Piaget, the child's language falls into two main types: first, egocentric speech in which "the child does not bother to know to whom he is speaking nor whether he is being listened to. He talks either for himself or for the pleasure of associating anyone who happens to be there with the activity of the moment. . . . He does not attempt to place himself at the point of view of his hearer; and second, socialized speech in which the child addresses his hearer, considers his point of view, tries to influence him or actually exchanges ideas with him." Piaget distinguishes three types of egocentric speech and subdivides socialized speech into five different categories. The first of the latter group, adapted information, occurs when "the child really exchanges his thoughts with others"; the second is criticism; the third consists of commands, requests, and threats; the fourth, of questions; and the fifth, of answers. About 1500 remarks recorded for each of two children six and one-half years of age during free play were analyzed by Piaget according to this classification in an attempt to study the logic and the thought processes of the child. He found that about 38 per cent of the child's remarks fall in the egocentric categories and that about 45 per cent are spontaneous socialized

language. When the answers are added to the spontaneous socialized speech, the total amount of socialized language is approximately 62 per cent. The same classification was used on about 800 responses secured from twenty children ranging from four to seven years of age and approximately the same proportions were found in each category. Piaget concludes that "it would seem that up to a certain age we may safely admit that children think and act more egocentrically than adults, that they share each other's intellectual life less than we do." He traces a series of stages to show that the young child is essentially egocentric and becomes gradually more and more socialized as evidenced by his language. He considers that "the language used in the fundamental activity of the child-play . . . is one of gestures, movement and mimicry as much as of words," and that "there is . . . no real social life between children of less than 7 or 8 years."

McCarthy (137) applied the Piaget classification, with certain modifications, to all the comprehensible responses in her data. The modifications used were the subdividing of the adapted-information category into naming, remarks about the immediate situation, remarks associated with the situation, and irrelevant remarks. Two other categories were added to those listed by Piaget, namely, "social phrases" and "dramatic imitation." The group which Piaget called commands, requests, and threats was extended to include all wish-words as well, and was called "emotionally-toned responses." Although the classification appears to be subjective, it proved to be quite reliable. The odd-even reliability coefficients ranged from .74 to .89 on the various items, and when 10 per cent of the records were scored independently by four individuals the averages of their correlations with each other for the various items ranged from .68 to .90.

The findings of this study did not confirm Piaget's results in that the percentages of egocentric responses were small at all ages, never exceeding 4 per cent. It was found that the three groups, adapted information, questions, and answers, showed marked relative increases with advance in chronological age. This tends to indicate that the very young child first uses language with regard to his wants. Naming showed a marked decrease and remarks associated with the situation increased with age especially after three years. The results of this study have added weight because they are based on a large number of representative children divided into discrete age groups, and because all four scorers, who used Piaget's definitions of the categories, agreed in finding small percentages of egocentric responses. Day (47), who duplicated this method of recording and of scoring in her study of twins, also found much smaller percentages of egocentric responses at all ages than did Piaget. At all except the youngest age level studied, Day found smaller percentages of the responses belonging in this category than did McCarthy. This she attributes to the more socialized environment of the twin.

The McCarthy and Day studies recorded the responses made in con-

versation with an adult who presented new toys and picture books to the child, whereas the Piaget material was gathered during free play and consisted of conversations among children. In order to test the effect of the situation in which the responses are recorded on the results of the various types of analysis, McCarthy (135) recorded fifty responses from each of thirty-one nursery-school children in both types of situations, the one identical with that used in her first study, and the other a free-play situation in the nursery school. In the former method the percentage of egocentric responses was 3.35, which agrees very closely with the figures on the more extensive study by the same author using the same method of observation. In the free-play situation, which was comparable to Piaget's method, the percentage of egocentric responses was 6.32, which partially accounts for the difference, but is still much smaller than the percentage found by Piaget. There is a strong possibility that Piaget's conclusions were largely influenced by the personalities of the two subjects whom he studied most intensively, whereas the McCarthy (137) and Day studies are based on larger and more representative samplings.

Further evidence in contradiction of Piaget is presented by Johnson and Josey (110) who attempted to repeat his experiments on fifty-five children. They state that their results "substantiate few of Piaget's claims." They state:

> "Instead of finding them egocentric we found them socially minded, willing and able to assume the position of another and even that of an hypothesis. They were quite able to make themselves understood. . . . Six year olds, he [Piaget] tells us cannot reason because they are too egocentric. We found nothing in our investigation to support this view. On the contrary we found all of our children to be socially minded and in no manner dominated by an egocentric attitude."

The authors are at a loss to explain this discrepancy.

Fisher's (68) study on seventy-two precocious children also attempts a functional analysis. After consideration of Piaget's classification, she abandoned it in favor of the traditional grammatical classification and used in combination with this three major categories based on the subject of the sentence. They were (*a*) remarks with the self as subject, (*b*) remarks with another person as subject, and (*c*) remarks with objects or things as subject. Obviously, the self could be the subject of a sentence in the grammatical sense, and yet the remark could still be highly socialized in the sense of McCarthy's interpretation of Piaget's terms. This use of the terms more nearly approximates the interpretation of Adams (1) who considers as egocentric those remarks which contain self-references. Fisher (68) found that 34 per cent of the remarks fell in this category and concludes that a high degree of concern with himself is characteristic of the preschool child. However, she found no correlation between age and the remarks with the self as subject. She states further that after the second year an increase in age does not bring about an increase in the amount of time the child talks about himself. Adams,

on the other hand, finds a regular increase with age in the percentage of egocentric remarks from 13 per cent to 41 per cent between two and four years. He finds a marked decrease in monologue and a slight increase in social monologue, both of which categories he lists as separate from egocentric responses. It will be remembered that the data for these studies were based on records made in nursery-school environments and hence should be more nearly comparable to Piaget's material. Fisher used a "coefficient of egocentrism," similar to that used by Piaget, determined by dividing the total remarks about the self by the sum of the remarks about others and those about things. The figure thus obtained for the entire group is .53 as compared with Piaget's coefficient of .48. A low coefficient of egocentrism (.31), found at the youngest age level, the author interprets as showing the difficulty of measuring egocentrism by means of language before two years. The other categories showed that the percentage of remarks about others increases with age up to the fourth year and then remains fairly constant, and that the percentage of remarks about things decreases markedly as age advances. The author points out that this indicates that the child is outgrowing the naming stage. This was found to parallel the percentage of time spent with things in the nursery school. Analysis with reference to the social activities of these children indicated that "there seems to be a tendency for talking about the self to be related to social, rather than to self activities." This would also tend to give some basis for the apparent discrepancy between the findings of Piaget and McCarthy with regard to the amount of egocentric speech. Fisher also finds an increase with age in the number of questions, with a peak in the fourth year. She finds a higher percentage of commands than McCarthy, probably due to the different situation in which the responses were recorded. This approach might also yield interesting comparisons between child and adult language, for Barnard's (7) analysis of the Phillips addresses shows 82 per cent declarative sentences, 6.8 per cent interrogative, 5.1 per cent imperative, and 5.9 per cent exclamatory sentences. Probably the apparent discrepancies in the results of these investigations in regard to egocentrism are attributable to differences in definition and interpretation of terms, which in turn result in varying criteria for the child's exhibition of his egocentrism through language.

Another investigation in which an attempt has been made to study the functions of child language is that by Rugg, Krueger, and Sondergaard (181) described above. The classification that they used contained the following items: self-assertion, self-deprecation, social consciousness, verbalized perception, linguistic experimentation, dramatic play, questions, rational thought, statements of fact, and answers of "yes" and "no." The large percentage (40.8) which they find in the self-assertion category confirms Piaget's reports of the young child's egocentricity. However, their definition of this group is much broader than his and does not exclude all socialized responses, for certainly many responses could be self-assertive

and yet highly socialized, as Piaget would use the term. It could include wishes and commands and many remarks directed toward an audience. The percentages of questions and of dramatic play coincide fairly well with those reported by McCarthy and, if certain other categories such as verbalized perceptions, statements of fact, and rational thought, which seem to correspond to McCarthy's adapted-information category, were combined, they would approximate the proportion represented by this group in her study.

Two recent studies have concerned themselves with single functional categories, namely, Smith's (199) study of the preschool child's use of criticism and Davis' (46) study on the form and function of children's questions. In the former it was found that 1.625 per cent of the responses in the author's previous investigation were "criticism." This type of response increased slightly with age from two to five years. Younger children tended to the "tattling" type of criticism, whereas the older ones complained directly to the offender. At every age unfavorable criticism greatly exceeded favorable criticism. A comparison is made with one hundred adult criticisms. Davis' study is based on 3650 questions taken down by mothers in series of fifty consecutive questions. The subjects were seventy-three children between the ages of three and twelve years and comparisons were made with questions from adult dialogues.

VII. Relation of Language Development to Other Factors

A. Sex Differences. From numerous indications in the literature, it appears that girls develop language more rapidly than do boys. Nice (155) reports a superiority of girls in extent of vocabulary; Terman (216) gives an earlier age for the appearance of short sentences among gifted girls than among gifted boys; Mead (138) found that feebleminded boys began to talk later than feebleminded girls. Doran (57), on the basis of an elaborate survey of the literature, states that girls have larger vocabularies than boys of the same age, but that the difference becomes smaller among older children. Stern (203) holds that girls are generally more imitative than boys and pick up words more correctly. Although Smith (197) found no significant differences in favor of either sex in the number of words to the sentence, or in the number of words per hour, she did find differences in favor of the girls in her vocabulary test at early age levels, although she states that boys later overcome this initial handicap.

Sex differences in favor of the girls appear in the comprehensibility of the speech at early levels. In the McCarthy (137) study, boys had only 14 and 49 per cent comprehensible responses at eighteen and twenty-four months, as compared with 38 and 78 per cent respectively for the girls at the same ages. Similar differences appear throughout the age range studied. Fisher (68) also found a higher percentage of non-verbal speech among the boys. They tended to repeat identical speech patterns more often than the girls. Both of these studies, as well as that by Day (47),

show small but consistent differences in favor of the girls in all other items of each type of analysis that show developmental trends. Similar differences appear in all three studies, not only in length of response (see Table 2), but in various items of the functional analysis, regardless of the direction of the age trend, and also in the earlier appearance of more complex sentence forms among the girls. McCarthy and Day both found definite differences in favor of the girls in the mean number of words, and in the mean number of different words used in their samplings. Blachly's (17) report on the vocabularies of fifty-one children at eighteen months shows that the boys used only 59 words while the girls used 78.6 words, on the average. Wellman, Case, Mengert, and Bradbury (227) found that girls tended to be superior to the boys on the articulation of consonant elements.

While problems of speech pathology are not within the scope of this chapter, it is interesting to note in connection with this problem of sex differences that in practically all reports the incidence of speech disorders is much higher among boys. Ley (122) states that all forms of difficulty in the development of language occur much more frequently in males than in females. Sommer (201) reports slight differences in favor of girls in progress in the correction of speech defects. There is also a higher incidence of reading disabilities among boys than among girls. Monroe (141), Terman (215), Goodenough (80), and others report slight differences in favor of girls in IQ as obtained on verbal intelligence tests.

It is interesting to note the gradual accumulation of evidence for these slight differences in the same direction. The only evidence to the contrary appears to be that the Fisher (68), Goodenough (82), and Davis (46) studies show no sex differences in the *amount* or *rate* of talking, and a few reports that boys exceed girls in extent of total vocabulary after six or seven years. This latter, however, might well be in accordance with the greater range of general information possessed by boys at this period as shown in studies by Hall (91) and by Probst (174). Similar differences in favor of girls are reported by writers in different countries, in studies based on highly selected groups (Blachly, 16; Fisher, 68), in those attempting to use representative samplings (McCarthy, 137; Day, 47), as well as among twins.

There are numerous reports of higher scholarship among girls in language and in other subjects involving language ability. Paterson and Langlie (162), for example, found that a selected group of University of Minnesota freshman men who exceeded the women in scores on the college ability test nevertheless fell far below the median score of the women on the Iowa Content Examination in English. Since it is generally conceded that verbal ability is at a premium in the academic situation, is it not possible that fundamental differences such as this may be at the basis of these differences found in scholastic achievement at higher ages?

B. Intelligence. It is quite generally recognized in the literature and in clinical practice that there is a definite relationship between age of

talking and general intelligence. An idiot is often defined as one who never learns to talk. Mead (138) and Town (218) report studies which show that feebleminded children begin to talk much later (38.5 months) than do normal children (15.3 months). Similarly, Terman (216) found that gifted children talk at a little over eleven months of age, about four months earlier than the average child. Summarizing the evidence on this point, Rand, Sweeny, and Vincent (176) state:

> "It is safe . . . to assume that children who talk unusually early are probably superior mentally; that feebleminded children are always late in talking; but it is not to be assumed that all children who are late in talking are feebleminded."

McCarthy (137) and Day (47) carried on all their analyses in relation to mental age and found that similar tendencies maintained in relation to mental age as were found in relation to chronological age. The sex differences and occupational group differences, though smaller, were still evident in all types of analysis when mental age was held constant.

Corresponding to all the sex, occupational group, and twin differences, there are differences in intellectual status, as measured by IQ. This brings up an interesting problem on which there is not sufficient evidence to warrant any definite conclusions, namely, whether the more precocious development of language among these groups is due to their greater intellectual endowment, or whether the higher scores on intelligence tests are due to more precocious linguistic development. The material on this point is obscure because of the emphasis on verbal items in the intelligence tests. As Goodenough (80) points out from an item-for-item analysis of the Kuhlmann revision at the preschool level:

> "It has been shown that more than half of the total number of items in the section of the scale under consideration are chiefly dependent upon types of performance in which females have been found to exceed males at all ages for which information is available, while the types of performance in which males have usually been found to exceed females are practically unrepresented."

Shirley (192) reports quite high correlations (five out of six between .63 and .76) between Minnesota Preschool Test scores and the following items: cumulative vocabulary, number of different words used per examination, and vocalization developmental scores. All correlations were higher at two years than at eighteen months.

Day (47) studied this problem in considerable detail in an attempt to account for the differences which she found between twins and singletons in language development. She matched her four-year-old group of twins with singletons, who were given the same mental test, in regard to total test score, chronological age at time of testing, sex, and occupational class. The percentages of the total score which each group earned on verbal and non-verbal items were then calculated and were found to match almost exactly. She therefore concludes that "the language re-

tardation of these four-year-old twins does not seem to have been a factor in reducing the total test score and thus lowering the IQ." She also determined "language quotients" for her twins by obtaining the ratios between the mean length of response of singletons and of twins of the same ages. The results indicate that "the language retardation is so significantly greater that factors other than 'below average general intelligence' must be responsible for it. The language quotient decreases rapidly as age increases in spite of the fact that the intelligence quotient does not."[4]

It thus appears that differences in intelligence do not account entirely for the language retardation of twins, nor does the verbal element in the intelligence tests appear to penalize the twin sufficiently to account for the differences in intelligence as measured. An interesting approach to this problem is suggested by the study by Pyles (175) on verbalization as a factor in learning in which 95 per cent of the young children solved the problem when the reward was hidden under a mould containing a picture of an animal. When they were given names for nonsense moulds, 44 per cent solved the problem, and when the moulds were unnamed, only 14 per cent solved the problem in twenty-five trials or less.

Garrison and Garrison (74) state:

> "Language and mental development are mutually dependent. . . . With language man is able to acquire in a relatively short time a great share of the things discovered in the past. Since an individual grows only as he reacts to the things about him, it is evident that language gives the individual a superior means of reacting and thus makes possible greater mental development."

Following a detailed discussion of language in intelligence test items at higher ages, Seago (185) concludes:

> "Intelligence has been defined in terms of certain abilities closely allied to facility in the understanding and use of words, and it follows naturally that tests involving a similar ability will correlate with it. This statement is not supposed to imply that the opposites, vocabulary, completion and analogies tests do not test abilities distinct from that of handling verbal concepts, but it remains to be demonstrated to what extent they are tests of 'language ability.'"

Space does not permit a discussion here of the controversial topic of the relation of language to thought. Piaget's (165) approach to this problem is perhaps the most stimulating. Reviews of this theoretical discussion are given by Mandell (131) and by McCarthy (137).

C. Motor Ability. Language is usually considered as a substitute or short-cut type of behavior for overt bodily responses; gestures accompany language in the early stages, and may even take its place in some instances; and, as language becomes more proficient, a waning of gesture language is apparent. Although the evidence is conflicting, there seems to be a tendency for boys to be more active (Goodenough, 82) and to be superior

[4]Reported from original manuscript through courtesy of the author.

in certain gross motor skills. These tendencies, together with the sex differences noted above, present challenging questions to the research worker. The available evidence is meager, yet Shirley (192), who made careful analyses of the motor development of the same children on whom records of language development were kept, points out that:

> "During the early weeks it seemed to the examiners that vocal play was temporarily arrested for a week or two before and after a new motor act sprang into existence, but was resumed again after the act was fully established. . . . The median number of utterances per examination period from 5 to 13 weeks always exceeded 1; from 14 to 23 weeks, the period during which reaching for objects was developed, median utterances were always 0. From 25 to 30 weeks both median and average number of utterances pursued an upward course, but they decreased sharply at 31 weeks, which represented the median age for sitting alone and remained low at 33 and 34 weeks, the median age for creeping. After median age of walking (66 weeks) the median utterances made a rapid rise and far exceeded the pre-walking records."

Correlations between developmental scores on locomotion and on vocalization were all low or negative, tending "to confirm the theory that speech development is held in abeyance at the time when locomotor progress is most rapid. Fine motor coordination also is little related to vocal progress at the age of reaching, 15-25 weeks. From 45 weeks on a moderate positive correlation was obtained at each of the ages for which the relationship was computed." While this evidence is meager, "it points in the direction that early vocalization is held in check by rapid motor progress and that babbling is a type of behavior which the baby resorts to when there is nothing better to do, or when the novelty of a new type of motor activity has worn off." Wellman, Case, Mengert, and Bradbury (227), who give detailed tabulations on the ability of preschool children to articulate various sounds, report correlations of +.67 and +.65 respectively between the scores on the tracing-path test and the total number of sounds and the number of consonant blends.

Goodenough (82) reports a low positive correlation (.17), with age constant, between talkativeness and physical activity in nursery-school children. Fisher's (68) correlation of .86 between the use of things by nursery-school children and talking about things is quite in line with Shirley's (192) result indicating a moderate positive relationship between vocalization and fine motor coordination after forty-five weeks. Johnson (109) reports that nursery-school children under three years of age frequently use rhythmic vocal accompaniments to their physical activity. Other interesting evidence on the relationships between language development and motor development, which is beyond the scope of this presentation, comes from the studies of pathological and neurological aspects by Travis (220) and by Orton (159), from the studies of disabilities in the secondary forms of language, such as those by Monroe (141), and from isolated

reports, such as those by Nice (149), Court (40), and others on retardation in language development associated with ambidexterity.

D. Environmental Factors

1. *Socio-economic status.* There is considerable evidence in the literature that indicates a marked relationship between the socio-economic status of the family and the child's linguistic development. Chamberlain (34) states that as early as 1847 Degerando reported that "'the child of the rich understands more words and less actions, and the child of the poor less words and more actions.'" This early observation of differences between economic classes in linguistic development has since been confirmed by a number of recent experimental studies. Drever (58), after comparing the vocabularies of his own three children (who had had a broad environment with considerable travel) with those of slum children, concludes regarding the effect of environment on the composition of the vocabulary:

> "Expansion of a child's environment always tends to increase nouns relatively to other parts of speech. Conversely, with a constant or relatively constant environment, the other parts of speech will increase relatively to the nouns."

This is in agreement with Bean's (13) observation that periods of rapid increase in vocabulary coincided with the widening of the child's experience through travel, and that periods of sentence building paralleled uneventful interim periods. This may be similar to the cyclical relationship between language development and motor development reported by Shirley (192).

Descoeudres (51) studied 300 children of the upper and lower classes, as they were distinguished by attendance at private or public schools, and found that on practically all items of her extensive battery of tests, nearly all of which involved language, the children of the upper social classes were decidedly superior to those of the lower social classes. Stern (203), who reworked these data, calculated that the difference between the educated class and the working class would be equivalent to about eight months in linguistic development.

Chamberlain (34) reports a study by Lombroso in which fifty children of well-to-do and educated families were found to have much larger vocabularies than one hundred children from poor families. In reviewing this study, Markey (132) states that "both in the precocity with which they interpret the words and in the exactness reached, the children of the former families exceeded those of the poor in the proportion of 2:1." The author concludes that the difference is attributable to environmental factors and not to defective intelligence.

Paternal occupation was used in McCarthy's (137) study as the criterion of selection in order to obtain a representative group. It was found that the mean length of response shows clear differences from one occupational group to the other, each group maintaining its proper rela-

tive position quite consistently. When this measure was calculated for the three upper and the three lower occupational groups, statistically significant differences were obtained. In the functional analysis of these data there were much higher percentages of adapted information and of questions among children of the upper occupational groups. In the construction analysis the children of the upper occupational groups were superior in every item showing age trends. In the analysis according to the various parts of speech the children of the lower occupational groups continued to use a larger proportion of nouns than did the children of the upper social classes. While this is contrary to Drever's (58) theory, it seems that the relatively large proportion of nouns is characteristic of the less mature type of vocabulary, and the persistence of this ratio at higher ages might be considered indicative of slower linguistic development among those children. The results of the Day (47) study on twins showed similar differences in all types of analysis when considered in relation to paternal occupation. The differences in mean length of response between the upper and lower occupational groups increased with advance in chronological age. A comparison of the results of Fisher's (68) study based chiefly on children from professional families with the findings of other investigations also brings out clearly the superiority in language development of the children from favored environments.

A recent study by Van Alstyne (224) on seventy-three three-year-old children indicates that the environmental factors studied correlated consistently higher with the results of the vocabulary test than with intelligence test results. Smith (197), Gesell and Lord (78), and Hetzer and Reindorf (95) also found positive relationships between linguistic development and socio-economic status.

2. *Age of associates.* There are a number of conflicting opinions in the literature as to the effect of the age of persons in the child's environment on his linguistic development. Some maintain that the child who associates with older people will be precocious in this respect. The Gales (72), whose second and third children used twice as many words as the first child at the same age, claim that "the later children have an advantage in learning much from contact with the older child." Others hold that children understand each other much better than they do adults who are too far above their level. Hall (90), in speaking of children of approximately the same age, says that "their noises are too well understood by each other, the younger holding the older back."

McCarthy (137) found that the median percentile rank on length of response of the children who associated chiefly with adults was 70. For those who associated with older children it was 42.5 and for those who associated with younger children, 52.5, indicating a tendency for association with adults to be conducive to precocious linguistic development. The results for the other two groups are the reverse of those expected, but are obviously due to an overweighting of the lower occupational groups among the children who associated with older children. Wellman, Case,

Mengert, and Bradbury (227) were unable to find any significant relationship between the number of older children in the family and the accuracy of sound production by preschool children.

Perhaps the best evidence on this problem of age of associates comes from the observations of Day (47), comparing twins and singletons in language development. Using identical methods, the findings of the McCarthy (137) study were corroborated except that the twins were found to be retarded in language development as measured by all four methods of analysis. This retardation became more pronounced with increase in age between two and five years. The twins showed the greatest retardation in those phases which are of the greatest developmental significance. Day (47) states that "the mean length of response for the five-year-old twins is slightly below that of three-year-old singletons," and a comparison of the yearly gains indicated that the rate of increase in length of response among singletons was about double that found among twins. She reports further that "twins resemble singletons in the nature of the developmental changes concerned with the construction of the sentence . . . [but] . . . it is evident that twins maintain longer, infantile habits of speech and progress at a relatively slow rate toward grammatical construction used by adults." In conclusion, she attributes the differences found to the peculiar social situation of the twin:

> "Aside from the possible inheritance of imperfect physiological factors concerned with speech, it seems more probable to expect the environmental factor to have a limiting effect. One surely could not learn as much or as rapidly, from companionship with an individual so nearly on his own plane, as from one in advance. Satisfactions from this companionship may be adequate to the twin . . . whereas the single child . . . may be motivated to gain his satisfactions from a wider field."

3. *Bilingualism.* The problem of bilingualism and its effect on language development is another question upon which evidence is scanty. McCarthy (137) found that, as measured by the length of response, the 10 per cent of the children in her group who heard a foreign language in the home surpassed expectations based on age, sex, and socio-economic status. Smith (198) studied five bilingual children who seemed to show some slight handicap present. Yoshioka (233) states, again on the basis of meager data, that older children can handle two languages better than younger ones, and that bilingualism seems to require a certain degree of mental maturation for its successful mastery. Grabo (84) reports in an unpublished study (abstract in 223) that in monoglot and bilingual groups matched on the basis of mental ability the English vocabularies of the bilinguals were 33 per cent below those of the monoglot group. However, if total vocabularies, English and foreign, were considered, the two groups were equal. Haught (93) suggests that the language handicap as an explanation of nationality differences in intelligence should be avoided until such a handicap is demonstrated by properly controlled experiments.

VIII. Need for Further Research

While the literature in this field is extensive, it is only in recent years that the problem of language development has been attacked on a large scale by trained investigators. As may be seen from the foregoing discussion, the results from the various major studies tend to agree in the general tendencies brought out, both as to the language sequence, and as to the direction of differences between groups. The same tendencies appear in the various modifications of the different types of analysis that have been employed. It seems that the various criteria of language development tend to reveal similar developmental trends; but further light is needed on the evaluation of these criteria, and on their interrelationships. Certain problems of methodology still persist, such as the appropriate techniques for recording the vocalizations of infants, the optimum length and occasion of conversation samples, and the aforementioned dilemmas regarding methods of counting vocabularies and of classifying words and sentences.

In addition, further data are needed on the prelinguistic babblings and the emergence of true language from them; on a comparison of child and adult language both oral and written; on the interrelationships between language development and intelligence test scores, and between verbalization and problem solving; on the relationship between language development and the development of motor coordination and directional tendencies; and on the relationships between language development and such environmental influences as example of adult usage, association with older siblings, institutionalization, nursery-school attendance, and bilingualism. The field is indeed a fertile one, and, because of the objectivity of language and its intimate relations with other factors of psychological, educational, and sociological interest, further investigation of these problems should prove fruitful.

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CHAPTER 9

THE SOCIAL BEHAVIOR OF CHILDREN[1]

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It was an American, Monroe, who in 1899 made the first questionnaire study of what he called the "social consciousness" of children (108). He asked 2336 school children in Massachusetts what kind of "chum" they preferred and made a statistical study of the moral qualities which the desired comrade should have; he also made a statistical study of the gangs and clubs in which children of five American cities were organized, using the material of Sheldon. Furthermore, he worked out a questionnaire on children's vocational aims, on their preferred games and toys, and tried to get hold of the social element of school life. He asked two thousand children what they would do with their pocket money if it were completely at their own disposal. He asked questions concerning discipline, class responsibility, punishment, and, finally, concerning group suggestion. It is interesting to look over his vast bibliography and to see the many topics which he pointed out for study. But very little was done in the decade after Monroe made this first start in the direction of developmental social psychology. There were a number of questionnaire studies, i.e., studies of children's ideals, children's ambitions, etc., but the lack of a systematic point of view was common to all those efforts. It is only in the last ten years that a systematic study of the social behavior and development of children has taken place.

There are two main aspects about which we can organize the presentation of facts, the *developmental* aspect and the aspect of social *types* and situations. The first gives a longitudinal view of the facts and of the successive stages in the general sequence of maturation. The second gives us, in cross-section, the variety of types of social behavior and of social situations. I wish to illustrate these two aspects in one example before I enter into the details of these two fields.

The first experimental study of children's social attitudes in the first and second year of life, published in 1927 by Charlotte Bühler (24), brought out the following facts. Suppose we place two infants of six to ten months facing each other in a ward and observe their communication with each other. We shall find, in the first place, some characteristics which will recur in a more or less marked degree with all infants of this age level.

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[1]I wish to thank Dr. Hetzer, Dr. Herzfeld, and Dr. Wolf who helped me to collect the material which is presented in this chapter.

The 1933 revision of this chapter has been done in cooperation with my American student, Dr. Ruth Klein.

Such characteristics are the active seeking of contact with the other individual, the interfering with the other by touching him, exchanging toys with him, or pushing and pulling him. Furthermore, it is characteristic of this age that the older and physically stronger and more skillful child becomes the superior in the situation, displaying himself more freely, while the other individual seems to be inhibited and restricted in his movements by this free display of the first. But at the same time—and this is our second point of view—we shall find even in this early stage marked individual differences among these infants in their social attitudes. There are some who, in spite of their being stronger or more skillful, always seem inhibited in the presence of another child; there are some who, in spite of a superior companion, are always aggressive and overactive. There are some who never seem to become aware of the other child and who seem to be interested only in their toys and their manipulation of materials. Thus it becomes quite obvious that, as stated above, the concrete social behavior which we observe must be regarded from two different points of view, first, the developmental aspect, and, secondly, the point of view of individual differences within the range of attitudes that are possible at a definite developmental level.

Social Behavior from the Developmental Point of View

How early in life does an infant realize the presence of another human being? This could be stated only if *specific* reactions to the human presence could be observed. Several investigations have been made in regard to this problem. Hetzer and Tudor-Hart (88) tested 126 children who ranged in age from one day to five months with different sound stimuli, including the human voice. The distribution of the 1461 reactions in regard to the twelve auditory stimuli is shown in Table 1. Although, among the different sounds and noises, the human voice in its different modifications has but a medium effect, and the indifferent conversational voice a slight effect, there occurs from two months on a specific reaction

TABLE 1

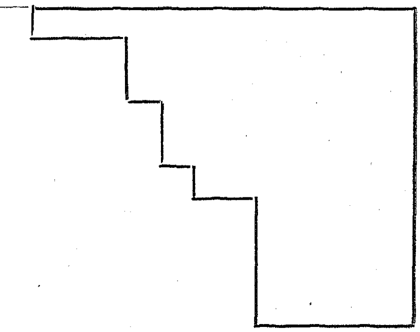
Percentage Distribution of Reactions to Twelve Auditory Stimuli

Stimuli	Percentage of reactions
Rattle	10.9
Whistle	10.5
Hand-clapping	9.6
Knocking	9.4
Noise of porcelain	8.8
Kind human voice	8.8
Angry human voice	8.5
Singing human voice	8.5
Noise of spoon	8.2
Sound of bell	6.3
Indifferent talk	5.4
Crackling paper	5.1
Total	100.0

TABLE 2

CAUSES OF CHILDREN'S LAUGHTER

	Age in months: 1 2 3 4 5 6 7 8 9 10 11 12
Social laughter*	
Laughter accompanying play movement and lulling	
Laughter when receiving bodily stimuli	
Laughter when offered toys	
Laughter at hearing words	
Laughter at change of posture	
Laughter at playing hide-and-seek	
Laughter upon awakening	



*By social laughter is meant that which occurs when the child sees or hears another person.

to the human voice in all its modifications, and that is smiling. The two-months-old infant, in fact, smiles occasionally at the sound of the human voice, even though at this age he does not yet smile at other stimuli.[2]

This finding confirmed the results of observational study in which the situations where smiling had occurred were tabulated. Table 2 was obtained in Hetzer's (30) inventory of 60 infants' activities in the course of an ordinary day of their lives.[3] The inventory shows us the same fact, i.e., that from six to eight weeks on, that is, at the end of the second month, smiling occurs as a specific reaction to the presence of a human being—when the infant hears the sound of the human voice or when he happens to meet the glance of another person's eyes.

The question might be raised as to whether this smiling in the presence of another human being occurs as a conditioned reflex. The first suggestion would be that perhaps it has been transferred from the feeding situation and its agreeable stimuli to the person who brings the food. Even the first scientific observer of the newborn infant, Preyer, stated in his observational diary that from about the tenth day of life his baby, after his meal, showed an expression of comfort in his face, similar to a smile. A regular smile Preyer reported to be observed in the fourth week. In the same way as sucking occurs together with the beginning and the initial stimuli of the food situation, so the reflex called expression of comfort occurs in the state of satiety, that is, at the end of the food situation. In case that at the end of the food situation, when the infant is satiated, no other stimulus except the mother's occasional talking and looking

[2]There is not yet any difference in the reaction to the mother's and other people's voices within the first five months. See Hetzer and Tudor-Hart (88).

[3]See Charlotte Bühler (30, Tables VI and VII, pp. 63, 64).

at the child were present, one might assume that the smile is transferred from the situation to the mother. At about the same time (in the second month) that the baby begins to smile at a person's voice and glance, sucking becomes a conditioned reflex. Ripin and Hetzer (87) found in their experiments that from about six weeks on sucking occurs as a conditioned reflex to those stimuli with which the customary food situation started.

On the other hand, one must not forget that practically all day long people surround the child and become effective as stimuli in numerous situations. So there is no special reason why just that one—the feeding situation—should have the conditioning effect.

Thus we shall state as the results so far obtained that at about six weeks the child begins to react to the human voice and glance differently than to all other noises and visible objects. The baby smiles. Possibly this smiling is a conditioned reflex transferred from the situation of satiety to the human being present at that moment. Yet, considering that this is only one of the many situations, painful as well as comforting, in which people surround the child, it is even more likely that the smiling is an original and primary reaction to the human voice and look.

The first reaction to the presence of another human being is a positive one, smiling. This is independent, in the beginning, of the person's facial expression or tone. Experiments to test this were made by Hetzer in the following way (32). The observer bent over the child once with a smiling expression and once with an angry expression on her face; she addressed the child once with kind, once with scolding words and tone; she made once an inviting, once a threatening gesture with her hand. Infants from three to ten months of life were tested, ten at each month of age. Later on, these first results were confirmed and standardized in situations involved in the "Babytests" (30). The results were as follows: The baby of three and four months reacts positively to the angry as well as to the kind voice and look; the five-to-seven-months-old baby reflects the assumed expression and also begins to cry at the scolding voice and threatening gesture; the eight-to-twelve-months-old baby, however, begins to overcome the suggestion of the unfriendly grimace, the scolding voice, and the threatening gesture, and smiles again in spite of them, sometimes after several seconds of hesitation.

The facts were interpreted by the authors in the following way: Up to five months, the infant has not yet become aware of the distinctions in expression and tone, but he reacts to look and voice independent of their modifications; the baby from five to eight months begins to watch the whole face, observes the gestures, and is affected by the expression of the voice—he reacts directly to the positive and negative impression; the baby from eight to twelve months overcomes the direct sensory influence and begins to "understand" the meaning of the seeming scolding as joke or play. That is why, after an initial hesitation, he begins to laugh and to give sounds of pleasure.

The first social contact generally takes place between the baby and a grown-up person. The baby reacts, but only because the adult's activity has caused him (the adult) to be perceived. If the infant happens to meet another infant's look, he reacts as well with a smile to that. But generally only in the second half-year is contact established between two children. Even four- or five-months-old babies when placed near each other often do not become aware of each other's presence (24). But the six-months-old baby begins actively to look around and actively to attract another baby's attention. He touches him, makes cooing sounds, and interferes with his activities. In the above-mentioned experimental investigation of Charlotte Bühler (24), the contacts which happen within the first year of life between two infants have been studied. Besides the initiation of contacts, the children were observed to interfere with each other by taking away or offering toys, by inhibiting the other's movements, by warding off another's attack, and by cooperating in play. Similar forms of contact between children in the first year of life were recently found by Il'inskij (91*f*). There is a marked difference between an aggressive and a more passive attitude and disposition, depending on age, situation, and individual type. The developmental aspect is that the older infant, in the first year of life, generally is the superior in the situation because of his better-developed motor coordination. The child who sits easily or moves around readily displays freely before the less fortunate child. This superiority and inferiority in the social situation is determined as such by the observer, and is not experienced by the children themselves. Klein and Wander (95*b*), who examined children between one and two years of age in situations similar to those observed by Charlotte Bühler, found that superiority is realized by the children in the middle of the second year, while inferiority is recognized at the end of the second year of life. In the first and second years, two children, when in contact with each other, will display friendly as well as unfriendly behavior. Which form of contact prevails depends upon the personality of the children. Mengert (107*b*), in a preliminary study, shows that between two children in the third year of life friendly behavior predominates.

Within the first year of life, the infant is not able to keep up an actual contact with more than one person at a time. In a group of three children, mutual contact is always kept up only between two of the three. Charlotte Bühler and Reininger (124) observed that at the middle of the second year of life, for the first time, three children begin to join in a group. Groups of three two-year-old children, placed together, were studied by Klein and Wander (95*b*). They found that 8 per cent of the observed children had no contact, that 67 per cent had contact with another child, and that 25 per cent of the children were able to keep up a contact with two other children at the *same time*. Fifteen per cent of the groups were such that three children had a momentary mutual contact. A simple random action of one of the children was taken up by the other two, so that all three did the same thing. It was noted that all complicated forms

of contact which are to be found between two children of this age do not appear in this first group of three. It appears, then, that the group of two has the preference up to three years. Then there is a continuous increase of the size of the groups during nursery-school, kindergarten, and school age. There exist a great many studies about children's group life at these ages. However, most of them are not very detailed or are merely descriptive in their results. First of all, the work of Thomas (151) and her cooperators may be mentioned. Starting from the same point of view as Charlotte Bühler regarding the importance of recognizing behavior units and significant data for the statistical evaluation of social behavior, Thomas has the merit of developing careful methods for the control of the observer. In regard to the present problem, one of her cooperators, Beaver, observed an embryonic gang of three three-year-old boys. There are some other observational studies. Challman[4] found in the spontaneous grouping of nursery-school children a preference for children of the same sex even among the two-year-olds. This same fact is stated by a French observer, Chevaleva-Janovskaja (43). Only when the groups are larger than two are both sexes mixed, while the small group is preferably restricted to one sex. Atkins observed ten two-year-old children throughout half a year and found them preferably joined at first in groups of three, later of four. *This fact that the group increased in number with age* was observed in detail by Wislitzky in Vienna (166). She observed 173 groupings as they actually occurred among 36 children in three observational periods of three times one hour. The children ranged in age from three years to six years and eleven months. Figure 1 is one of her curves showing in percentages the preference of each group. The group of three has obviously the preference with preschool children from three to seven years of age. Complete isolation is rare. There are, with each year, fewer solitary children. Another of Wislitzky's tables tells us that the percentage of solitary children is 8 for children between three and four years, 5 for those between four and five years, 2 for those between five and six years, and 0 for those between six and seven years. There is, at the same time, among the older children, an increasing tendency to join the larger group. More than 50 per cent of the three-to-five-year-old children participate in groups larger than three members. Doroschenko (51) carried out studies in Russia similar to those of Wislitzky and has reported the results of her work and also those of the Russian psychologists, Saluschny (128) and Schewelew, who had worked on the same problem. Their observations were that groups of three or even of two members are characteristic of the kindergarten age. They found 33 per cent of their groups composed of two members and only 12 per cent and 11 per cent of the groups with four and five members, respectively. Larger groups than five are rare. These groups all exist for only a short time, only a third of all groups remaining intact longer than twenty minutes.

[4]See "Work of child development research centers: a survey." *Child Stud.*, 1930, **7**, p. 299.

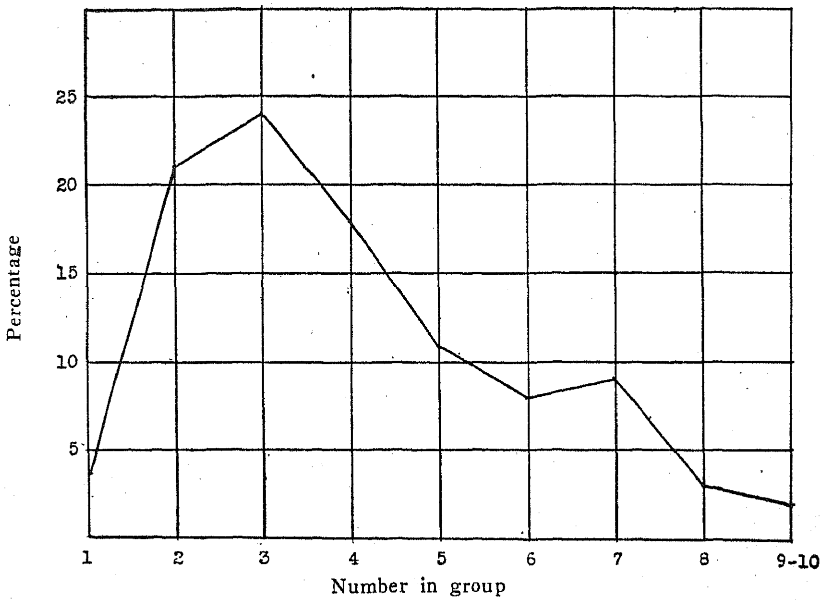


FIGURE 1

PERCENTAGE DISTRIBUTION OF GROUPS IN RELATION TO THE NUMBER OF MEMBERS

Many observers agree that, from the second year on, children may react even passionately against being excluded from a definite group. Charlotte Bühler (27) reported situations in family life and Erich Stern (141) situations in kindergarten life, where this reaction could be noted.

Finally, we mention the Russian study of Sevaleva and Krasuskii (135). They observed one- to one-and-one-half-year-old infants and found that 41 per cent of them played in groups; those older than fifteen months participating more in groups than the younger ones, and boys more than girls. This last fact has also been noted by a French author, Chevaleva-Janovskaja (43).

What Are the Factors Which Bring Forth Contact and Result in Group Formation?

The child is part of his mother before he becomes an individual for himself and is part of a definite group for a long time before he can enter and join any group actively. He becomes aware of this community only gradually and to the degree in which he actually experiences the relationships with the members of the group. Thus the first contacts are brought about not by the child, but by the others. The situations in which the child initiates contact are at first only those in which he needs help. The infant uses vocalization, that is, he cries from the very first day when he has needs until someone comes and relieves him.

From about three months on the infant initiates contact not only when

he needs help but also in a simple play situation, for the mere pleasure of it, or—as we must assume—for companionship. In such a case, the baby cries, for instance, when people leave his bed or when people enter the room and do not pay attention to him. The six-to-eight-months-old baby moves eagerly towards a person who is present in the room but who does not approach him. He stammers and squeals. He tries to draw the person near, if he can reach him. The same is true of two children placed near each other in a ward. Charlotte Bühler (24), in her experiments with infants, sometimes placed two children near each other without giving any further stimulus. In the majority of cases, infants of the second half-year of life will come into contact. They will touch each other, smile, squeal, and utter sounds, and perhaps they will begin to play with each other's clothes or feet, or to make movements in front of each other. They may forget each other after a while. Persistent contact, however, will be formed only on another basis, that is, the presence of a material in which both children are equally interested.

Klein (95) examined situations in which children in the first and second years of life turn spontaneously to the adult. The child of a year and three months will demand *specific* help from the adult. At the same age, a child will seek the protection of the grown-up in a given situation. In an experiment it was noted that at eight months the infant will turn with a questioning look to the adult.

If a ball is thrown into a crowd of kindergarten or nursery-school children a group will immediately form around it (Hoffmann, 89*a*). Some want to see it; some want to have it. Wislitzky (166) found that the three-year-old children prefer to watch other children doing something with the object. Especially when these young ones are with a number of children, they are more likely to watch than actively to participate in the group. The same thing was observed by Hetzer (80) in a study of street play and group games in the streets of Vienna. The two- and three-year-old children are happy if they are allowed to run with the crowd; they are mere spectators. From four years on, not only an activity but also an object can become the center of a group.

Helplessness and need, companionship in play, and common interest in some material or toy have been enumerated so far as causes inducing contact and group formation on the part of the child. There is still another and more advanced situation in which the child seeks contact, that is the situation in which he wishes information or discussion of something. One may say that this is only another situation of helplessness, or another kind of companionship—mental companionship—or another, namely, mental material, as the underlying factor. But the mental exchange of ideas through the means of *language* gives this contact quite a new basis. From the end of the first year the wish to be informed about names or facts and to have questions answered brings about many contacts between child and adult. Piaget (117), in his studies of children's talk and reasoning, emphasizes that their talk is much more *egocentric* than social. That

means, in Piaget's opinion, which is based on extensive observational material, that children from three to seven years accompany all their manipulations with talk which actually is not so much intercourse as monologue. It is agreed, however, among other authors—e.g., William Stern and David and Rosa Katz—that this result is due to the special conditions of life in the "maison des petits" in Geneva, where Piaget's work was done. The Katzes (94) emphasize, in opposition to Piaget, that even the special relationship of the child to each of the different members of the household is distinctly reflected in the respective conversations. This is surely true of all the dialogues which they published.

It was mentioned before that even in the first year of life there are marked differences in the equilibrium and assurance of infants in the social situation. Some are self-assured, some are intimidated by the presence of the other child, and only a few seem not at all to consider the other's presence. In Charlotte Bühler's (24) experiments only the infants younger than half a year and a few of the older infants displayed the latter reaction. From six months on, it is a rule that a definite relationship is established in a short time. This may be the relation of superiority and inferiority, but it also may be that of equality and continuous rivalry. Both dominance and rivalry can be displayed in different ways, in aggressive as well as in productive activities. The child who dominates by intimidating, overcoming, or attacking his companions and the child who dominates by inspiring, encouraging, or leading them can be distinguished from the second year on. The features of these earliest "leadership" tendencies are, first, that the child in no way loses his balance in the presence of the other infant whom he may even console when weeping, and, secondly, that he leads the play in initiating and demonstrating certain gestures or activities.

Barker (9), in her study of nursery-school children, also tentatively calls certain children "leaders." They initiate a great many more contacts than other children. Wislitzky (166), whose observations were made in a public kindergarten in Vienna, found one boy leader in her group of thirty-six children. Adelberg (2), who had charge of a private kindergarten in Vienna, made a special study of the three leading children in the group. They were one boy and two girls, among twenty children, equally divided as to sex. The study is centered around the boy, the real leader. In this little community, spontaneous play groups included preferably two and three children, in rare cases four, and even as many as twelve children. There was one boy, however, who was found to take part in groups of each size and with all children. He had more contacts than any other child and was leader in all groups. The ages of the children ranged between two years and ten months and six years and seven months. This boy was four years and ten months old. He was leader because of his suggestions and his organizing ability. He named the participants of the various groups. His suggestions and plans appealed to the group and seemed to be made by the group. This latter characteristic was particu-

larly evident when the activities of this child "leader" were compared with those of other boys who became leaders for short periods, but, who, by insisting on their own wishes, quickly lost their following. Even at this early age the leader is characterized by the same qualities which we shall also find to be decisive for leadership in later years, *initiative, organizing ability,* and *conformity* with the substantial tendencies of the group.

Among the games of kindergarten children, we find a number where the rôle of a leader is a constituent part of the game. In playing "house," which is always introduced by girls, according to Hübsch and Reininger (91*c*), the rôle of mother is the most important one. No one wants to be the "child," and consequently the "children" are often the passive, bashful, and usually the younger members of the group. The same is true of the boys' games of playing train, auto, steamer, etc.

As the earliest evidence of leadership in the first year of life, we indicated the initiative of a child who performs and demonstrates a game which the other then takes up or imitates. This presupposes that there is an imitator as well as an initiator. Imitation is known to be an important factor in all social cooperation. What do we know about imitation in the earliest stages? Guernsey (72), in her very thorough experimental study of the beginnings of imitation, showed that infants imitate certain movements and sounds from two months on, and, in addition, imitate manipulation of material from the end of the first year. She studied spontaneous imitation under various conditions and observed that in each period the child imitates only certain definite movements or manipulations—i.e., those in which he is interested. This is confirmed by Valentine (153*a*), who states that at twelve months and at two years the tendency to imitate any very interesting action is very strong in some children.

One of the main sources of contact between the adult and the child, especially in very early childhood, is the fact that the adult does so many things in which the infant is interested and which he eagerly tries to copy and to learn. The first commands which the infant understands are the suggestions to copy a certain gesture or movement which the adult demonstrates to the child. In an experimental investigation made by Klein (95) on the understanding of *positive* and *negative commands,* the author found that the one-year-old child understands and obeys simple positive commands with explanatory gestures. Such a simple command as "Give me that" is understood and obeyed by 80 per cent of the one-year-and-three-months-old children. The negative command, however, is not understood until later. In the beginning, the one-and-one-half-year-old baby obeys such a command only so long as the authority watches him. An effect of a forbidding command in the absence of the adult is not observed before the third year. Reactions against such a command occur as early as the beginning of the second year. Their percentage is as high as 60 at the end of the second year, the beginning of the so-called period of obstinacy.

This *period of obstinacy* is, within definite limits, considered a part of

normal development (26). Continuous observation carried on by Worel (171) indicates that with nearly every child between two and three some incidents happen which call forth in the child a strong emotional reaction against his environment. Wylie (40*c*) experimented with situations which call forth obstinate behavior in preschool children. Neglect, i.e., a situation in which the child was ignored for 15 minutes, incurred the most obstinate reactions (84 per cent). Seventy-four per cent of the children reacted with obstinate behavior when certain acts were forbidden. Simple commands, such as "Sit down!" and "Come!", did not call forth such behavior. Boys seem somewhat more inclined to display obstinate behavior than girls. The ready adaptation of those children who never oppose the adult during this so-called period of obstinacy has been considered unfavorable for the child's later development, as will be discussed in a later section of this paper.

At this age (between two and three years) we find a new attitude towards toys when the child is with a group of other children. As other experiments have shown (Hetzer, 84*a*), the child now *builds* with blocks. Klein (98*a*) found that the child of this age, when with other children, either just holds his building blocks and carries them off into a corner, or spends the time in filling a box with small blocks, dumping them out, and filling them in again. Only 9 per cent of the children examined really built with the blocks. Play material is now regarded as *property* and is cautiously guarded.

The school situation as a new social experience is our next problem. Here we wish only to raise the question as to what new social tendencies arise during the school age. Reininger (122, 123) published the results of two observational studies dealing with the social habits of elementary-school children in the first and fifth grades. The first-grade children in Vienna are six to seven years old; the fifth-graders average about ten to eleven years. The fifth-grade study dealt with boys only. The first-grade study was carried out in the following manner. Thirty teachers and psychologists observed for several weeks after the opening of school the first social contacts of all the newcomers in thirty different schools. Thus the origins and occasions of the contacts between children were carefully watched. From the developmental point of view, we are interested in the fact that the groups enlarge in size and that some more constant relationships, e.g., "friendships" of two comrades, begin to persist. *The class does not yet act as a whole.* The leaders are leaders of groups, not of the class as a whole, and their influence is not yet permanent. When we compare these interesting facts with the observations made by Adelberg (2) in her kindergarten, we find that, whereas in the kindergarten group consisting of twenty children, there was obviously one very gifted boy who was able to become the center of the entire group, in the school class of thirty to forty children such leadership seems to be impossible even for the children of the first grade. This fact was also observed by Rombach (126), who made a similar study with an elementary class in Freiburg.

In the fifth grade, the class's acting as a whole is very obvious on certain occasions. *Class leaders* and *group leaders* can now be distinguished. The group leader is a specialist who, under special circumstances and conditions, organizes a group under the auspices, so to speak, of the class leader. Such a leader has at this age the same characteristics as were evident in the kindergarten age. He has initiative or at least intelligence enough to accept every good suggestion which is brought to him; he is able to recognize the main tendencies of the group he is leading; and, with all that, he somehow represents the *ideal* of the group and its developmental stage. For example, since sport plays an important rôle in the life of the ten- and eleven-year-old boys, the leader must be under all conditions a good sportsman, he must have vigor and vitality and, in every case, good general intelligence. "He is too dull to be the leader," said even the kindergarten girls in Adelberg's class, in regard to a certain boy whom they tentatively had tried as their leader. The stages through which a crowd of children pass in gradually becoming organized from within the crowd itself are the following. In the beginning there is the unorganized crowd in which only a few single contacts are made. These single contacts are the basis of group formation. Each group puts forward a leader, and this leader now organizes the group or even the whole community. Lazarsfeld (101), as a result of a little observational study made in a kind of camp, maintained that giving functions to the community as a whole makes its members feel and act as a whole. Therefore he arranged a general assembly. But even in this assembly it is only through group organization that the whole gets its formation.

As soon as a centralization in the personality of a leader has taken place, the crowd gradually becomes a whole. This process is very well shown in Reininger's (122) study with the fifth-grade elementary class. This class, which was originally formed from two separate parts, was split from its origin and gradually became one whole only through the superiority of two leaders who became centers for the whole crowd.

How such a centralization is brought about becomes obvious in connection with the following details: Soon after the members of a community have learned to know each other, a certain order is established. Each member has certain functions, plays a certain rôle, and has a certain rank in the community. If the problem is raised in such a community of making a kind of rank order of all members, of indicating the most and the least important ones, there is no hesitation or doubt. Reininger was the first to make this suggestion to his class of boys, and several authors followed him. The ten-year-old children are able to make such a rank order, but the younger ones cannot do it with the same degree of success. There are some outstanding characteristics about such ranking. There is complete agreement about the first and the last ones in the rank order. Only in the middle of the scale are the members arranged in subjective arbitrariness. Friends and good comrades receive relatively high ranks in this part of the scale.

The place which a child receives in such a ranking does not depend upon his good or bad scholarship or upon special performances in any particular regard, but is obviously based on a kind of general impression of his personality as a whole. Intelligence and rather good scholarship form a part of this impression, but are not the decisive part.

Reininger's method of observation and questionnaire has been taken up by several other authors, e.g., Leib (102), Rombach (126), and Broich (21). We shall come back to their studies when we consider the question of types. There are some other facts which are of more immediate interest. Fuxloch (61) observed the same tendency which other authors found with younger children and which we have mentioned before, i.e., among children of school ages, also, a comrade of the *same sex* is preferred, and in mixed groups, increasingly, contacts with children of the *same age*. There are, however, exceptions to this rule. For instance, Hetzer (80) observed in the groups playing in the street that frequently the older girls

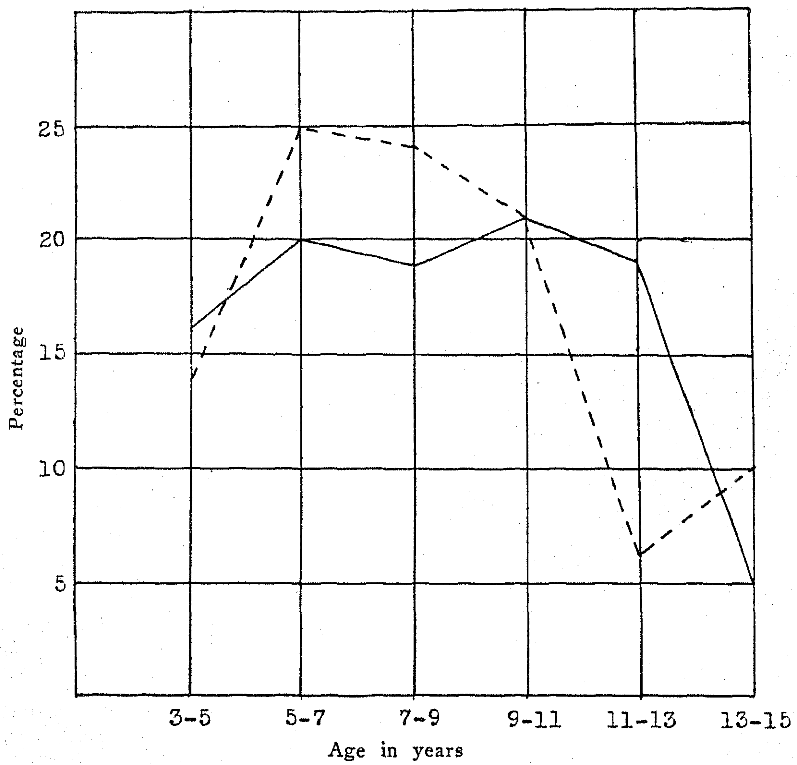


FIGURE 2

PERCENTAGE DISTRIBUTION OF GROUP PLAY IN RELATION TO AGE AND SEX

[From Hetzer (80, p. 13).]

Boys ————

Girls — — — — —

played a motherly rôle with respect to the smaller children of the group. The interest in group games can be well judged from Hetzer's curve showing the distribution of the ages in regard to their participation in group play (Figure 2).

There is another feature which shows the progress of social organization during the school years. Hetzer (80) made an observational study of the old traditional games which children play everywhere in the streets. Studying the large collection, she found that there are two types of group games which have a very different structure. There is one kind of group game in which definite *rules* prescribe everything which is to be done, i.e., certain movements which the participants have to perform or certain words which they have to sing or say to each other. And there is another kind of game where the rules are only schematic and general and where complete freedom is left in regard to the single performances. Games of this second type are "hide-and-seek" or "the robber and the princess," where entire freedom is allowed as to the direction in which one runs, the places where one hides, and the time; while a game of the first type, e.g., when all the children form a circle and sing a song, prescribes exactly the direction in which two children have to run around the circle to catch one another, and so on. The games with the definite rules prevail among children from four to ten years of age, while from that age on the games with free organization are more popular. *It seems that a group of children under ten years needs a definite plan to keep it together, while the older group keeps together even when the order is left free and only a general scheme is prescribed.* This conception has been confirmed by various observations. Children younger than four do not take part in the regular group games, but run after their older playmates and try to copy and follow them. We present in Table 3 some of Hetzer's data which show the distribution of children in relation to the type of the game and to age. This table shows that up to ten years both sexes follow the same type of behavior in regard to our problem, while from ten on a difference can be observed. The boys from then on appear to be more independent than the girls.

Finally, we mention the results of a questionnaire investigation made by Haase (73) in Halle. He got twelve hundred answers from boys and

TABLE 3

PERCENTAGE DISTRIBUTION OF CHILDREN IN RELATION TO THE TYPE OF GAMES PLAYED AND TO AGE

Age in years	Sex	Following no order	Copying others	Following definite orders	Following organization	Total
3	boys and girls	33	55	17	0	100
4-6	boys and girls	16	30	51	3	100
4-10	boys and girls	2	18	60	20	100
10-15	boys	0	10	23	67	100
10-15	girls	0	16	25	59	100

TABLE 4

PERCENTAGE OF BOYS AND GIRLS LISTING THE VARIOUS CLASSES OF DISLIKED TRAITS

(Letters refer to classification of traits given below.)

Class of disliked trait	Boys	Girls
a	34	37
b	24	32
c	15	9
d	17	12

girls between the ages of ten and fourteen in regard to the question: "What do you not like in play?" The material which the author collected seems to be very interesting, and would offer valuable information if the statistical evaluation were better than it is. We shall try to organize his statistical material so far as is possible. In regard to age, it is unfortunately impossible, but there appears to be some useful results in regard to sex. The author classified his data under four main headings, with the sub-arrangement of the specific disliked traits, as follows: (*a*) failure to fit in with the group as a whole—self-will, obstinacy, boasting, shirking; (*b*) dishonesty—quarreling, violating the rules of the game, lying and cheating, partiality; (*c*) lack of comradeship—destroying and taking away toys, disturbing the game, teasing, envy; and (*d*) unsocial character traits—clumsiness and carelessness, inconstancy, rude, noisy, indecent behavior. The percentage of boys and girls who listed traits under these four categories are shown in Table 4. (The percentages do not total 100 because there were some traits listed which did not fit in the author's fourfold classification and this unclassified group is omitted.)

If any conclusions are to be drawn from these data, we would suggest the following: People complain most of those things from which they have had to suffer most. The fact that the girls dislike traits of the first two types more than do the boys, and that the boys dislike traits of the last two types more than do the girls means that girls in their play groups suffer more from their playmates' lack of public spirit and lack of honesty, while the boys are more pained by teasing, and by clumsy and destructive behavior.

Thurstone (152*a*) investigated a new problem; he studied the influence of motion pictures in changing the social attitudes of children. Schedules revealing the attitude on the issue which was involved in the film were filled in by the children before and after seeing the picture. The children were more severe in their judgments of gambling after seeing a picture where a gambler was shown than before seeing it. It would be advisable, however, to have the children fill in the second schedule after a longer interval and not, as was the case in this study, on the day after seeing the film. We would then be able to determine if a lasting effect was obtained.

There are many changes in social behavior during *puberty*. We have

already met with one of the first changes which take place. In Figure 2, which shows the distribution of the participants of different age groups in group play, we see a rapid decrease among the girls between eleven and thirteen, and among the boys between thirteen and fifteen years. We see with the girls that from thirteen to fifteen there is again an increase of participants (from 6 to 10 per cent), while with the boys, our table does not include the next age groups. Through a questionnaire, Lehman and Witty (101*b*) found 47 girls' play activities and 48 boys' play activities whose waning parallels the onset of puberty. Furfey's study (60*a*) shows the same results. What do these figures mean, and how are they to be explained? Is this age group which does not participate in group play less interested in play or in companionship, and if so, why? We shall see that, in fact, this age group has certain *antisocial tendencies* and that a definite explanation can be given for that fact.

There have been similar tendencies observed on other occasions. Hetzer (78) made an observational study of girls in a kind of recreation center, a home (*Hort*) where children may spend their time after school, and can play and work under supervision. The girls observed ranged from six to fourteen years in age. They played and worked in groups and formed a rather permanent community, with the exception of a certain age group which brought constant fluctuation into the group structure. These were the girls from eleven to thirteen, who for weeks sometimes avoided the home, or came irregularly, or did not join the group activities. This antisocial period, with its passive or active antisocial attitude, lasted from two to six months and generally ended with the first menstruation. We call this period, which has some other indications of a negative attitude towards life, *the negative phase*. One of the criteria of this negative phase is the antisocial disposition. A similar negative phase was observed in boys between fourteen to sixteen years (79). The same observational studies showed that, immediately after the "negative phase," new and very strong social tendencies awake and bring about new social relationships. These new social relations in the adolescent's life are the "crush" and the friend. This means that, in different forms, after the self-isolation of the negative phase, a strong *attachment to a single person* becomes the compensational need of the next period, the period of puberty. And this person is generally an acquaintance of this new period, not one from the old authorities or companions.

In Hetzer's (78) observational studies of girls and of some boys (79) in the adolescent period, the transition from a definitely antisocial behavior to a strong attachment of a new kind could be followed up in detail. In some cases the adolescent, returning from his isolation, chose a friend to whom he clung from then on. In some cases a devoted love or heroworship of some individual began.

Such an adolescent *friendship* becomes quite different from that which the child has known as friendship before. Vecerka (156) made a ques-

tionnaire study[5] of the problem of friendship. She collected answers to the question of how many friends the writer had and wished to have, which qualities he esteemed most in his friends. Vecerka found that only from thirteen years on do girls begin to make a definite distinction between comrades and a friend; that, from then on, they prefer to have only one friend, while before they enumerate two, three, or even more. The study was made as a detailed observational study of one class, in addition to which fourteen hundred girls of different schools were included through the questionnaire. Mutual confidence, mutual understanding, and mutual love are the qualities which are required for friendship in adolescence. The pre-adolescent children give much less definite answers, they wish a "nice," "good," and so on, friend. Rombach and Reininger, in their study of elementary-school children, confirm this observation that personal friendship is seldom found among these younger children. The characteristics of pre-adolescent friendships are described by Danziger (43*c*), who observed girls in a camp. In friendships between two girls of eleven to thirteen years of age the emphasis is placed on showing the others "that we are friends." They like to wear the same kind of clothes, to fix their hair the same way, etc., thus enjoying playing the rôle of friends. The bonds are very superficial, as the inner meaning of a friend is not yet understood. Jenkins (91*i*) finds that children between twelve and sixteen (mean age, 14.3) tend to have friends of the same chronological and mental age. Fifty-four per cent of the children's friends were in the same school and 25 per cent lived in the same neighborhood. Intimate friendship is by all authors considered a characteristic of adolescence, not of childhood. In the diary of the adolescent much space is devoted to writing about friends in an intimate way. Rödleitner (125*a*) made a special study of this problem.

That love or devotion which one calls *"hero-worship"* is also considered as a very characteristic feature of puberty. Charlotte Bühler (23) studied, on the basis of adolescents' *diaries,* the distribution and types of hero-worship during puberty. Her collection of about one hundred authentic diaries contains contributions from different countries, different milieus, and different age groups. There are German, Austrian, American, Czech, Swedish, and Hungarian diaries in this collection (22, 25, 145). Statistics show that the average age at which girls begin to write diaries is thirteen years and eight months, while the average age for boys is fourteen years and eleven months. In all of the girls' diaries either a "crush" or a flirtation plays a rôle, sometimes both. The period of the "crush" is from thirteen years and nine months to seventeen years. The boys' diaries show a larger variety of types of friendship. In the place of the "crush," a devoted admiration for a leader or for a girl, or often for an older woman, plays a rôle.

[5] The first study of this kind was the questionnaire of Monroe (108). Delitsch (47), a German author, also tried to make a statistical study of the friendships among the pupils in his class.

Leadership was mentioned before as one of the factors of group organization. From early childhood on leadership originates in the group. The leader among the younger children, however, does not play the essential rôle which is his among adolescents. Winkler-Hermaden (165) made a special study of the leaders in different groups participating in the German youth movement. He found definite characteristics in their personalities and tried to analyze their appeal to their followers. With each of the three types of leaders—of which we shall speak later—certain needs of the adolescent are satisfied. He needs a leader as well as he later needs love. The leader must represent somehow his personal *ideals*.

This problem of the children's and adolescents' ideals has been investigated through dozens of questionnaires.[6] The trouble is, however, that children generally are not able and adolescents not willing really to answer questions about their ideal or model. From a very early age on, in fact, they copy people and worship or envy people whom they would like to equal. But this is sometimes not conscious and, if conscious, not likely to be confessed. Monroe (108) has reported some observations about his little daughter, who, at the age of three, very markedly copied and adored a little girl whom she had known for a short time only. There is not yet any exact knowledge as to the extent to which such veneration and attendance are of practical effect in development. It is known that the analytic school attributes a great importance to the "imago," as they call such a model, and they believe in a very specific effect of the father and mother imago in early childhood.

Hill (88*a*) asked 8813 school children to answer the following question: Of all persons whom you have heard, or read about, or seen, whom would you must care to be like or to resemble? Why? From six to eleven years of age, children choose their ideal from the immediate environment—parents, teachers, acquaintances. After eleven, the greatest percentage of ideals is selected from the remote environment—historic Americans, contemporary, public Americans, and foreigners, historic and contemporary.

It is only from the age of puberty on that we have more detailed data about the ideal or idol which the adolescent chooses and which he follows. The utterances of adolescents in regard to this idol show that it is the specific stimulus of a certain personality to which they react at this age and which may have a decisive influence on their development for years, sometimes for life.

The first group formation, composed at the beginning of two, then three, and later of an increasing number of members, is the child's contribution to the creation of society. In the beginning, these groups are quite ephemeral. They have no permanence, no stability, no definite organization. It has been found that only when boys reach the age of eight to ten do they suddenly, on a certain day, decide to form a group that has a name, an organization, and a purpose. They decide to become a gang

[6]There is a complete bibliography in a Viennese dissertation of Hans Feichtner which will be published later.

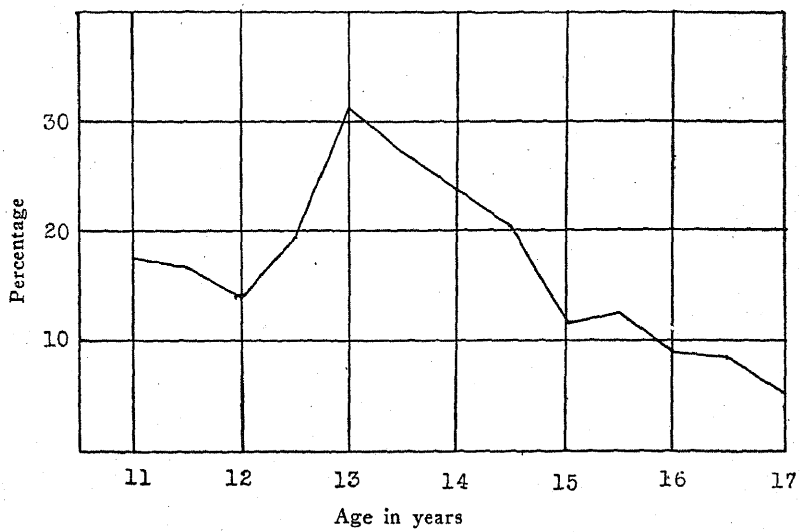


FIGURE 3

PERCENTAGE DISTRIBUTION OF GIRLS PARTICIPATING IN GROUP ORGANIZATIONS IN RELATION TO AGE
[From Vecerka (156).]

or a club with such and such an aim. It is the first act of social formation which is done with decision. Bernfeld (15), who collected several hundred papers in which high-school boys reported about their membership in gangs or clubs, found that in German and Austrian high schools from 2 to 100 per cent of the pupils of a class were incorporated in associations. One of the earliest American investigations in the field of the psychology of adolescence was concerned with the problem of boys' gangs (92). Vecerka made the first parallel investigation on girls' societies (156). As she collected material from fourteen hundred girls, she was able to give a statistical survey. Figure 3 is one of her curves. The highest percentage of girls participating in a club, 31, was found to occur at the age of thirteen. The curve gradually increases and decreases to and from this peak. The girls after fourteen consider that the time for clubs has passed.

The most extensive study of gang life was made by Thrasher (152), who is really the authority in this field. This study of more than one thousand gangs in Chicago shows very clearly that the gang is a transitional social need of the adolescent, at a period when he is no longer completely devoted to the family from which he originated and, on the other hand, has not yet founded a family of his own.

It seems that the German *youth movement* was so very successful originally partly because it met this general need of adolescents to associate in definite groups (19). Martin,[7] who made a questionnaire investigation

[7]Unpublished Viennese dissertation.

of *political* interests of adolescents in Vienna, found that up to sixteen years the wish to join an association is much more decisive for the participation in a political group than the political interest itself.

Types of Social Behavior

The general development of social behavior was our first topic, the types of social behavior which can be observed in different situations throughout infancy, childhood, and adolescence constitute our second topic. This problem, however, has not yet been studied in the same degree of thoroughness and detail as the first. It is, indeed, a much more complicated problem than the first. This complication is brought into the problem as soon as we not merely describe and distinguish the several types of social behavior which can be observed but ask how they are to be explained. Are they hereditary modes of response or do they develop under special circumstances? In the following presentation of the problem we endeavor to emphasize facts which have been observed, not theories. We enter the discussion of the above-mentioned problem merely by pointing out those facts which may in the future help to solve it.

What do we know about *normal types of social behavior* in childhood and adolescence? That is the first question to be asked. The earliest data were collected in a study of infants in the second half-year of life. Charlotte Bühler (28, 29) observed and described *three types* of social behavior in babies of this age. These types were called *the socially blind, the socially dependent,* and *the socially independent* behavior. The criteria are the following: (*a*) The socially blind infant behaves in the presence of another child as if nobody were present; he looks at the other without any emotion, he takes toys, plays, and moves without any regard for the other child; he does not pay any attention to the other's movements; he is neither impressed nor interested in the other's presence or activities. (*b*) The socially dependent, on the contrary, is deeply impressed by the other's presence and activities; he can either be inhibited or else be stimulated by the other's presence. In the first case, he will not move, will watch the other or copy him, will obey him, and sometimes even give signs of fear in front of him; in the second case, he will display in front of the other, will demonstrate objects and gestures, will try to rouse the other, and sometimes will even get enthusiastic and excited. In both cases all his movements are dependent on the presence of the other child; he observes the effect of his behavior on the other and carefully watches the other's reactions. (*c*) The third type is still different. The socially independent child is one who—though aware of the other's presence and responsive to his behavior—yet does not seem dependent on him, is neither intimidated nor inspired. He reacts to the other, wards him off when necessary, yet never becomes aggressive himself. He may or may not join the other in play, is not inconsiderate, but sometimes even consoles the other, encourages him, takes part in his activities; yet, with all that, he remains independent

in his movements; for instance, he may suddenly turn away and do something for himself.

These three types were observed with infants from six to about eighteen months of age. They occurred independently of whether or not the children had had previous contacts with others, also independently of whether or not they were only children, independently also of their home conditions, and even of their nationalities, as these studies were made in an immigrant neighborhood in New York. Thus it seems very probable that these typical attitudes depend on a *primary disposition* and not on *environmental conditions*. Some of the babies were retested in several contacts with older and younger, superior and inferior, children and seemed not to vary in their typical disposition and attitude. It remains to be seen, of course, whether these pioneer observations will be confirmed by other authors. The attitudes of dominance and submission have also been stated by other observers of early childhood, for instance, by Walker[8] in Minnesota.

We have characterized in our three types three general social attitudes of the individual. Another way to distinguish types is to observe *types of contacts* within a group. Reininger and Rombach both observed new pupils in the first weeks of school. Rombach, in fact, continued his observations throughout a year. Two types of contacts are noted by both observers. From the beginning of the new group life, the shy and uncertain child clings to the self-assertive; and this relationship, in which *protection*, motherly attitudes, despotism, dominance, and submission play their respective rôles, is found to be a very definite type which recurs in all children's communities. Reininger (123) found that when several children of the protective type somehow had lost their protégés each began to look around for another similar child for the sake of his or her protectorate. A second type of contact which is observed by Reininger as well as by Rombach (126) is a *devotion* of a certain kind. The object of the devotion is characterized as a gentle, friendly, and attractive fellow, who himself is not particularly social, not particularly eager to make friends, but who, in spite of this indifference, soon becomes the center of a swarm and the object of many advances. All children seem to like him, they wish to sit near him, to serve him. His type is a sort of finished harmony. He is not a leader and never becomes active in his group, he is merely an attractive center.

The rôle which the child plays in a children's community, according to Reininger, is from the beginning a rather definite one. The observer soon distinguishes the *protective* type, the above-mentioned *beloved or popular* child, the *leader*, the *despot*, and the *socially unsuccessful* child. As the success of the beloved child depends not so much on his social activities, but is obviously due to his personal grace, so the lack of success is very much bound to traits of the individual's character or even to his

[8]See "Work of child development research centers: a survey." *Child Stud.*, 1930, 7, p. 299.

appearance. The neglected and poor child, whose dress is torn and dirty, or the child with physical defects is socially unsuccessful as well as always the mischief-maker, the quarrelsome child, and the one who always knows better. The despot who dominates in the first and second year of life through force (Charlotte Bühler), but begins to be rejected in kindergarten age (Adelberg), is no longer successful in school age. His position is distinctly different from the leader's. Though there is one type of leadership, which Winkler-Hermaden calls the sovereign type, in which some traits of despotism can be noted, there must be other traits than mere despotism to insure leadership. Two different types of leaders are distinguished by Chevaleva and Sylla (43*a*), who studied children from five to fifteen years of age. In their very special, controlled situation, they differentiate between a leader who assumes the responsibility for upholding the situation and letting the others partake in it and one who wishes to control the entire group, not permitting the others to take an active part.

Types of leadership have been characterized by Winkler-Hermaden (165). He finds in his material—questionnaire answers from sixty leaders in the German and Austrian youth movements—three types, the *sovereign,* the *pedagogue,* and the *"apostle."* While the sovereign is a more egocentric type who is admired and followed on account of his own suggestive personality, the pedagogue is a leader of a more unselfish type who is absorbed in the care of his group. The apostle, finally, centers on an objective aim, towards which he leads; his leadership is of a more impersonal character. Winkler-Hermaden found that in early puberty (twelve to fourteen years) the personality of a "sovereign" type appeals to the youth who at that time looks for a strong and suggestive personality; that in puberty (fourteen to sixteen years), the type of the "pedagogue" has more appeal because of his unselfish devotion and his understanding of the problems of his confidents; that in later puberty (sixteen to eighteen years), however, the type of the "apostle" has better chances of success because he follows and represents a certain ideal towards which he inspires the adolescent. Keilhacker (94*a*), who questioned school children as to how they would wish their teachers to be, obtained results which are comparable.

Social behavior may also be considered in regard to types of *temperament, intelligence, character.* Social behavior is not merely a simple functioning of one of the three types which we have described. We have already seen in the case of leadership that a certain personality may appeal to one group as a leader and not to another. Thus whether a certain type becomes a leader or not depends not merely on the person's character, temperament, intelligence, and further qualities but also on the needs of the respective community. Hollingworth (90), in her study of gifted children, reports a very interesting case of a boy who did not stand out at all but was very solitary among his first school playmates and yet immediately became a leader when placed in another class. The trouble was that in the first community he was so much ahead of the others that he

had practically no relationships with his comrades at all, while the second group was able to appreciate him. Hollingworth draws the conclusion that "the leader is likely to be more intelligent, *but not too much more intelligent,* than the average of the group led" (p. 131). Here it appears very clearly that the social rôle which one plays depends on the situation as well as on the individual. The difficulties which are sometimes caused by this isolation, resistance, or antisocial attitude of the child may be brought about by any one or a combination of three fundamental causes. That is, adjustment troubles may arise either because of the child's personality, the social situation, or, as we have already suggested in the first section of this paper, because of his developmental stage. This complexity may be the reason that we are so completely lacking in results as to the problem of social behavior and social development in relation to character and temperament. Personality types as described by Kretschmer or by Jung have been investigated lately in their correlations with intelligence as well as with character, and, of course, also in relation to temperament, but not yet in relation to definite types of social behavior, and not at all in connection with developmental problems.

In still another category of types, the investigator, after studying a certain social phenomenon, then classifies his subjects in regard to the extent to which they possess this attribute. Thus Washburn (158*b*), in a study of the smiling and laughing of infants in the first year of life, speaks of three types of infants in regard to the phenomena of laughing and smiling. A similar procedure was followed by Hunt (91*d*), who examined and analyzed the play of the preschool child.

There exist many *case studies* in which some evidence is given of a correlation of certain general features of personality with social attitudes. For instance, Woolley describes in her case study of "Agnes" (168) a very evident connection of a certain ability for organization with an early habit to direct and to boss people. Elsa Köhler (98), in her very careful case study of "Aennchen," gives strong evidence of the interdependence of abstract intelligence, the very intellectual type of this three-year-old child, with her egocentricity. But there are not yet any general rules as to the correlation of type of social behavior and type of personality.

The term "problem child" suggests at least two types of problems which can be included also in our special topic, social behavior. The problem child may show in a greatly *exaggerated* form those modes of social behavior which also occur with normal children in less exaggerated forms. Or the problem child may show definite *deviations* from the normal social habits.

Such exaggerations of the normal social behavior of the child, as well as the deviations from it, occur (*a*) in those developmental metamorphoses which seem to disequilibrate the organism and during which even the normal child has to pass through certain difficulties; (*b*) in such *situations* or changes of situation which require a special or new adaptation; and (*c*) under abnormal *constitutional* conditions.

TABLE 5

PERCENTAGE DISTRIBUTION OF OBSTINATE CHILDREN IN RELATION TO AGE

Age in years	Percentage of children
0-2	11
2-4	24
4-6	20
6-8	15
8-10	7
10-12	11
12-14	12
Total	100%

TABLE 6

PERCENTAGE DISTRIBUTION OF BOASTFUL CHILDREN IN RELATION TO AGE

Of all the children in these age groups	the following percentages were boastful
6-8	14
8-10	19
10-12	25
12-14	12

There are social behavior problems with the normal child at certain phases of his development. We mentioned above *stubbornness* as a normal developmental feature between two and four, and again later with the onset of puberty. Exaggerated stubbornness is one of the most frequent problems which parents bring to the advisory bureaus of the psychologist or to the physician. The cases of exaggerated stubbornness which were brought into the advisory bureau of the Viennese *Kinderübernahmsstelle* were distributed in age according to the percentages given in Table 5 (81). The highest percentage of 24 occurs in the same age group as that in which obstinacy is characteristic with normal children; the same is true of the lowest percentage of 7, and also of the increasing percentages of 11 and 12. It is to be considered as a deviation from the normal, however, when this stubbornness extends to other periods. Benjamin (14), among his neurotic cases, finds 25 per cent of the girls and 65 per cent of the boys having a prolonged period of obstinacy during the age range from four to ten, and 10 per cent of the girls and 33 per cent of the boys from six to ten.

We mentioned above the *negative phase,* a period shortly before maturity is reached (with girls eleven to thirteen, and boys fourteen to sixteen). This negative phase is preceded by a period of extreme vitality,[9] which we call the *period of increased self-power.* In this period, also, average children begin to boast. Hetzer found in a group of 170 children from six to fourteen years of age the distribution of boastful children given in Table 6.

[9]Compare the curves of increase in length and weight in Baldwin (8).

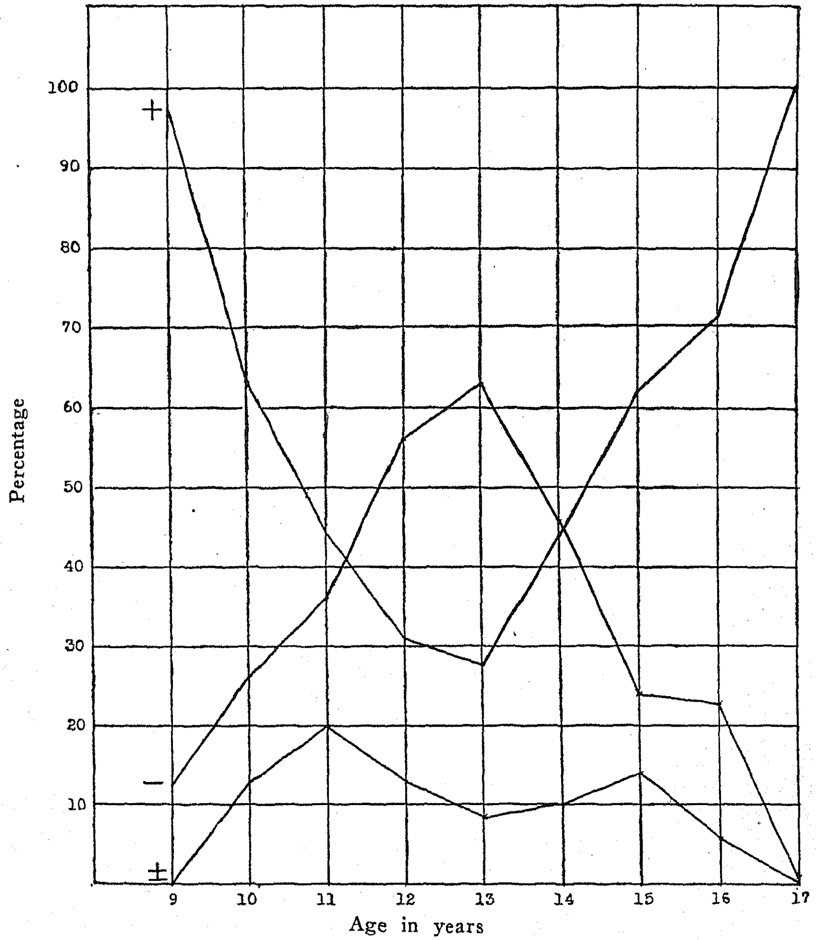


FIGURE 4
PERCENTAGE DISTRIBUTION OF GIRLS' GOOD, MEDIUM, AND BAD SOCIAL RELATIONS WITH MEMBERS OF THEIR FAMILIES
(From Busemann)
+ ——good relations
± ——medium relations
— ——bad relations

In the negative phase following the period of increased self-power, a negative social attitude towards the whole environment is a normal phenomenon. In addition to the facts above mentioned, I refer to one of the tables of Busemann (35)[10] which illustrates this statement. Busemann collected material dealing with self-criticism of adolescents. Girls, especially, make many statements concerning their social relationship with

[10]I published three of his tables in *Kindheit und Jugend* (26).

the members of their families, the school, or with their friends. The distribution of good, medium, or bad relations with family members, according to these statements, is as shown in Figure 4. It is most interesting to see in this curve that in the period of the most intense positive or negative feeling towards the others (nine, thirteen, seventeen years), the medium plays no rôle, while in the transitional stage from positive to negative or negative to positive feelings, the statements about "medium" relationships increase also to some extent. The peak of antisocial disposition is clearly seen to be reached at the age of thirteen. The corresponding age of fifteen with boys does not so clearly stand out in their respective records.

We shall now see how the pathological exaggeration of the self-assertive and of the antisocial tendencies is again found in the same period as the normal unsettled stage. The following curve is taken from a study (not yet published) made by Ekenberg and Herzfeld in Vienna (53). It demonstrates the percentage of adolescents of each age group who had come into institutions because of vagrancy or acts of violence. The peaks of the curves fall at the ages which correspond to the unsettled, antisocial ages given above. These adolescents are youths who are either brought up in neglected homes or are constitutionally abnormal.

We have corresponding age studies of juvenile delinquents. The percentages of delinquencies demonstrating extreme self-assertion or antisocial disposition display a distribution similar to that shown in Figure 5. I refer to material collected by Gruhle (70) from 105 boys from the institute Flehingen. The misdemeanors of these boys were stealing, begging, vagrancy, sexual delinquencies, and acts of violence.

We may refer also to Müller (110), who finds that, among all juvenile delinquents in Germany between twelve and sixteen years of age, the highest percentage, namely, 33, is found between fourteen and fifteen years, and 29 per cent of these are boys. Oseretzky (113*a*), in a study of the problem of beggary among children from eight to eighteen in Russia, finds that

TABLE 7

PERCENTAGE DISTRIBUTION OF JUVENILE DELINQUENTS IN RELATION TO AGE

Age in years	Percentage of delinquents
5	.95
8	4.76
9	6.67
10	5.71
11	5.71
12	**19.05**
13	8.57
14	8.57
15	**20.00**
16	10.48
17	7.62
18	1.90
Total	99.99%

TABLE 8

Distribution of the Highest Percentages of Juvenile Delinquencies According to Age (H. Gruhle)

Type of delinquency	Boys' ages	Girls' ages
Acts of physical violence	11	10-12
Unsocial behavior	12-14	12-14
Vagrancy	13-15	14-15
Sexual delinquencies	14-16	14-15

54.4 per cent of beggar children are between fourteen and sixteen years of age.

Ekenberg and Herzfeld found, in corroboration of Gruhle, the highest percentages occurring in the years as shown in Table 8.

In respect to definite deviations from normal social behavior, we find certain attitudes which are common to abnormal children as well as to abnormal adults: the sociability without inhibitions which is characteristic of the hyperthymic, the inclination for individual partnership of the schizoid type, the indifference of the depressive type, etc.

Social Behavior in Different Life-Situations

A comprehensive study of the family situation *as such* is being made by Charlotte Bühler. Thus far twenty children have been observed in their homes over a period of many months. The object of the study is to try to obtain as complete a picture as possible of the entire family situation, not isolating, as has been done in the studies of Freud and Adler, any single point of view. The extensive records are now being statistically analyzed. From this material it is possible to compute, among other things, the number of positive environmental factors which a child must have in order that its development may progress normally. A number of general factors have been found which influence the child in a positive way, as, for example, having both parents at home. The non-existence of any one of these factors may be evaluated as negative. Thus, by adding the positive and negative factors under which a child lives, a measure of the goodness or badness of his environmental conditions is secured.

Before the psychological situation of the child in the *normal family* was investigated, all kinds of problem situations were studied, e.g., the illegitimate child, the foster child. Then psychologists became interested in the only child, later in the situation of the child among brothers and sisters and of rich or poor families. There is still a large field for study on the part of psychologists as well as of the sociologists, economists, criminologists, educators, and biologists. We select, of course, only those facts which concern our problem, the social behavior of the child. And we shall ask the following question: What facts are known about the influence of the above-mentioned family conditions on the social behavior of the child?

The psychoanalytic and individual-psychology schools were the first to call attention to the situation of the child in the normal family. Freud and his

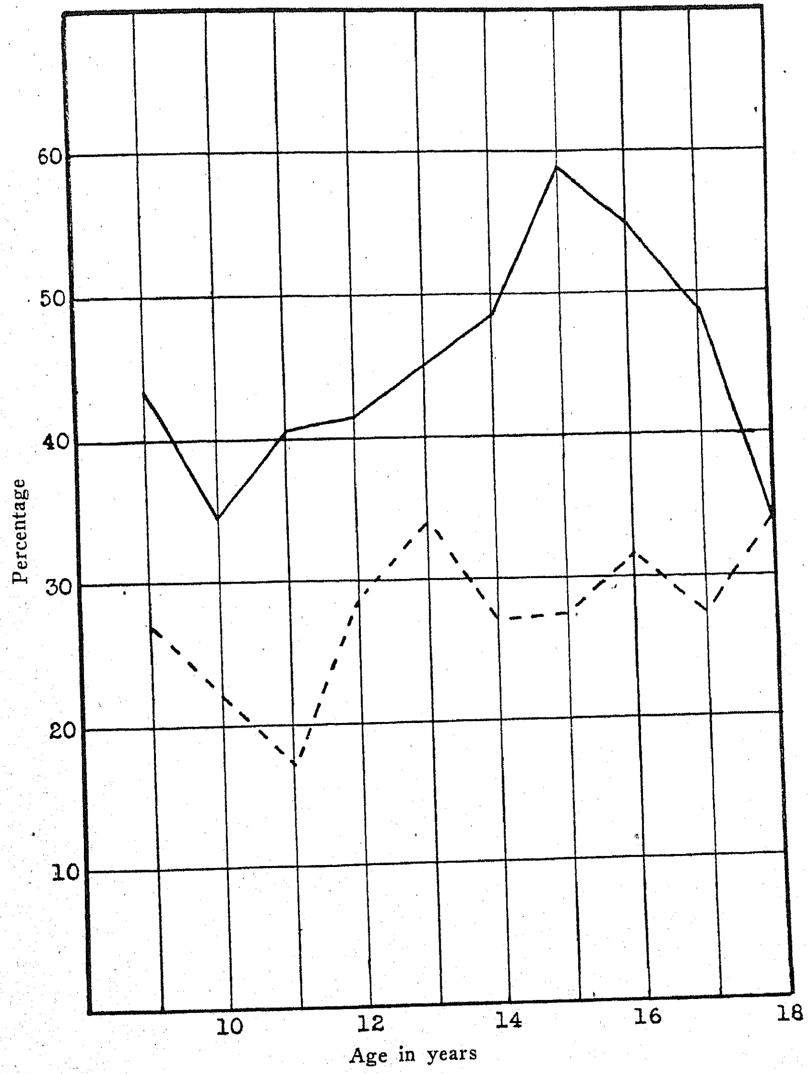


FIGURE 5

PERCENTAGE OF BOYS AND GIRLS FROM TEN TO EIGHTEEN YEARS OF AGE WHO CAME INTO AUSTRIAN INSTITUTIONS BECAUSE OF VAGRANCY OR ACTS OF VIOLENCE

Boys ————
Girls – – – – –

followers analyze the child's sexual relationship with family members and maintain that the whole later development of the individual is influenced by the early experiences in these relationships (*Oedipuskomplex*) (57). Adler considers the social position of the child among the family members and maintains that the later character development depends largely on this (3, 4). His main principles, which Freudenberg (58) has tried to prove statistically, are that the position of the oldest child is the most favorable so long as no sister or brother is born, while then it becomes a difficult one; that the position of the middle child is the least favorable; and that the youngest child is always in the position of the spoiled child. Since the first statement of these principles much research has been done in regard to this problem, the results of which seem very well expressed in a study of Goodenough (67), who says: "There is probably no position in the family circle which does not involve, as a consequence of its own peculiar nature, certain special problems of adjustment." It is not always the only child which is difficult. In Goodenough's material the position of the oldest child seems even more difficult than that of the others. The order of birth is not demonstrated to have any important relation to the development of a maladjusted or neurotic personality according to a recent research by Wile and Noetzel (161*a*).

Busemann (34, 40) collected some interesting statistical material in a study of elementary-school children. He found that the best average school performance was correlated with very different family constellations in different milieus. In the poorest milieu the only child had the best average school performance. This is easily understood because of the lack of room and quiet in poor surroundings where there are many children. In an average milieu, the best average performance is made by children who have one brother or sister. In the best social milieu, the most favorable result was found with children with two brothers or sisters. These results are in conflict with Adler's contention that the family constellation as such is decisive.

The *only child* has been found socially difficult in many studies. He is generally advanced for his age, seven months ahead of the other newcomers at school. Later on, according to Blonsky (18), and Machaček and Tremel (105), 60 per cent of the only children rank among the best pupils. At the same time they are nervous (Friedjung, Neter, Czerny), overeducated, talkative (Busemann), and antisocial either in a passive or active manner, timid or dictatorial (Blonsky). They are not popular among other children (Blonsky, Machaček, Maller); and, while children with many brothers and sisters are in the highest percentage among the gay children, the only child is among the sad children (Busemann). American authors who have recently made a comparative study of the only and non-only child have emphasized the superiority of the only child (Guilford and Worcester, 72*a*, 170*a*) and have shown that those characteristics usually attributed to the only child (sadness, nervousness, etc.)

are not necessarily found among them more than among non-only children (Hooker, 91*a;* Fenton, 54*a*).

The *reaction of the child to the family constellation* is not in accordance with the objective advantage or disadvantage. The child himself wishes brothers and sisters, although it is not to his material advantage to have them (Busemann).

Character and social attitude of the child are endangered more by other factors than by the position among brothers and sisters. For instance, *the child who has only one parent* is less efficient in school (Busemann) and offers more educational difficulties (Freudenberg) than a child from a normal home. The *illegitimate child* is among those with bad physical development, inferior professional training, and among the prostitutes and juvenile delinquents (Spann, Walter, Klumker, Müller). A high percentage (18 for girls, 10 for boys) of the neglected children are *step-children* (Kühn). The step-child develops some specific traits in his social attitude: a tendency to reflect in early years, as his whole position is problematic; distrust; and, on the other hand, self-assertion and sensitiveness were observed especially in girls (Kühn). The most difficult is the position of *foster children.* They originate from the lowest classes of the population (according to Viennese statistics, 40 per cent of the mothers were servants, 36 per cent of the fathers occasional laborers, 28 per cent of the parents had no regular income, 32 per cent were illegitimate children). A detailed research in regard to the psychological relationship between foster mother and foster child was made by Danziger, Hetzer, and Löw-Beer (44). The characteristic social attitude of the foster child is his uncertainty, which appears to result from his uncertain life-conditions.

Institutional Conditions and Social Behavior. The problem as to whether the best conditions of life for the growing child are to be found in an institution or in a family has been discussed since the eighteenth century (Beeking). There have been radicals advocating public education as well in the eighteenth century as today (J. Watson). Yet not until recent years have the psychological conditions of institutional life been thoroughly investigated, and now general opinion is inclined more and more to favor family life rather than institutional life. This has become the practice even with "handicapped children" (Wallin). Most of the psychological research which has taken place has been done in the direction of *intelligence testing.* The question raised is: In how far does the institutional condition of life have an influence on the child's intellectual development? Investigations in regard to this problem have been made by Carr-Saunders; McCaulley; Gordon; Jones; Kniese; Pintner; Stenquist, Thorndike, and Trabue; Weintrob; Streeter; Schmitt; and others. Their results are in agreement in showing that the institution child is intellectually *retarded,* especially in all performances in which language is required. For instance, among 250 institution children between nine and sixteen years, only 50 were found to equal the average of New York children, even though the latter came from a poor neighborhood. Thorn-

TABLE 9

PERCENTAGE OF CHILDREN FROM THE DIFFERENT ENVIRONMENTAL SITUATIONS WHO PERFORMED THE TESTS

Environmental situation	Hetzer-Koller developmental test	Hetzer-Reindorf language test
Children from institutions	47	36
Neglected family children	78	80
Foster children	90	95

dike and his cooperators find that this retardation increases with age in language tests, but not in performance tests.

The *social attitude* of the children is also influenced by the institutional life. Loosli-Usteri examined 84 Swiss children between ten and thirteen years, using the test of Rorschach, and found an *introverted, autistic* attitude prevailing.

The unfavorable influence of the institutional environment is noticeable even in the earliest period of life. Gindl and Hetzer tested 60 children, 20 institution, 20 foster, and 20 very much neglected family children, all between one and two years of age, using the Hetzer-Koller (30) test series for the second year. Table 9 presents their results. In spite of the good health condition of the institution children, they were mentally more retarded than neglected family children, not to speak of the foster children. This last result has been confirmed in an investigation with 275 Austrian foster families (Danziger, Hetzer, Löw-Beer).

Sturm made a special study in which she compared the psychological situation in the institution with that in the family by observing nine-months- to six-year-old children, some of whom lived at home, and some of whom lived in an institution. Her observations extended through the entire twenty-four hours of the day and brought out some remarkable facts. Comparing, for instance, the number of contacts which occur between the family child and other people and between the institution child and other people, she finds the most extraordinary difference, the family child having a great many more such contacts (Table 10). The situation is even less favorable for the institution children when the kind of contacts is studied. For instance, a five-year-old institution child receives 85 orders in the same period of time during which the family child receives 21; the two-

TABLE 10

NUMBER OF CONTACTS BETWEEN CHILD AND OTHER PEOPLE DURING ONE DAY

Age in years	In the institution	In the family
0-1	25	137
1-2	62	261
2-3	169	243
3-4	178	279
4-5	133	263
5-6	177	226

year-old family child asks 69 questions during one day, while the institution child has so much less opportunity for that that he has only 10 questions answered; while the family child has things explained in 28 situations during the day, the institution child receives only 3 explanations. Thus, we see that it is the institutional situation as such which offers to the individual much less opportunity to learn. With the two-year-old children it was still possible to make up for the loss suffered because of their institutional life when they were brought into favorable milieu (Hetzer); but with children older than that, it seems impossible to compensate for their early privation (169).

The Cultural Milieu and Social Behavior. The social level of the child's surroundings has, from a very early period on, a particular influence on the child's social development. In an environment where no one has time or interest to instruct the child, where he is always left to himself, where he lacks the example of manners, where he lacks intercourse and stimulation, his chances are, of course, poorer than in the opposite case.

The one-year-old child of poor milieu has been found one month behind the average in understanding human behavior and mimicry (Hetzer and Wolf). His disability to express himself properly becomes the main handicap of the child of poor milieu. We give one table as an illustration (Table 11). Descoeudres (48) gave language tests to children between two years and six months and seven years and six months and found in poor milieu a general retardation which William Stern (146) calculated at eight months. Goodenough found the same with children between two and three years.

The dependence of school work on the milieu has been noted by many authors (Bartholomaei, Cohn and Dieffenbacher, St. Calvin and Allen, Katz). Argelander (7) gives some representative scores. In the variety of expression in describing a picture, one hundred accounts of the *g*-chil-

TABLE 11

RETARDATION IN THE DEVELOPMENT OF SPEECH OF CHILDREN IN POOR MILIEU*

Age (years and months)	Good milieu	Poor milieu
	Percentage of Children Using Meaningful Words	
0:8-0:11**	65	0
1:0-1:2	91	40
1:3-1:5	100	71
1:6-2:0	100	100
	Number of Words Which Are Used	
1:0	7	0
1:3	49	1
1:6	91	4
1:9	121	8
2:0	216	27
2:6	†	92

*The data for this table were taken from (80).
**0:8-0:11 indicates 0 years 8 months to 0 years 11 months.
†Too many to be scored.

dren[11] correspond to 70.5 accounts of the *p*-children. The investigation was made with children from five to thirteen years. The differences decrease with age. The school levels them in both directions. In performance tests the differences are not so great (62).

The social life of the *p*-child has, so to speak, quite other accents from that of the *g*-child. The separation from the family is less complicated with the grown-up *p*-child (Rada). Fewer conflicts in opinion and aims occur. The attachment and detachment is not so personal.

One of the most interesting differences can be stated in the attitude of *g*- and *p*-children towards group life. The *g*-children, growing up in small families in which they receive individual care, are much more inclined to amuse themselves with individual games with any sort of material. The *p*-children, on the other hand, prefer group games from the beginning. There may be many reasons, of course, which work together in bringing about this situation, e.g., the *p*-children's lack of play materials, their growing-up in a crowd, and their not being accustomed to any kind of isolation or even privacy. Studying the distribution of individual and group games among *g*- and *p*-children, Hetzer (82) found 90 per cent of group games in the case of *p*-children and only 38 per cent in the case of *g*-children of all age groups.

In their general attitude towards society, the *p*-children very early demonstrate a much greater adaptation to reality than do the *g*-children. Answering a questionnaire as to whether the adult's authority is to be recognized or not, half the *p*-children and only a third of the *g*-children mention practical reasons for an affirmative answer (Rottman). Answering a questionnaire as to whether lying is necessary or not, 50 per cent of the *g*-children and only 1 per cent of the *p*-children answer negatively with moral arguments; most of the *p*-children think that life makes lying necessary (Bühler and Haas, Tudor-Hart). Also in the positive direction, the *p*-children tend to adapt themselves more to their life-conditions. Their vocational ambitions do not exceed their concrete possibilities (Hetzer), their willingness to obey or to fulfill certain tasks is greater; practical necessities and responsibilities are earlier respected by the *p*-children. On the other hand, their interest in the general problems of civilization stays much behind the *g*-children (Hetzer).

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[11]We use from here on the abbreviation "*g*-children" and "*p*-children," the first meaning children who are well cared for and in good social milieu, the other meaning children who are not well cared for and in a poor social milieu.

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CHAPTER 10

LEARNING IN CHILDREN

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GENERAL DIFFERENCES BETWEEN LEARNING IN CHILDREN AND IN ADULTS

Learning in infants and in young children differs sufficiently from learning in adults to make special investigation of the former desirable, not only from the point of view of the child and its proper education, but also from that of a better understanding of adult learning. It is essential to distinguish carefully between *learning* and changes in behavior due to such factors as fatigue, maturity (either general or specific, as in the development of receptor or effector systems), lesions, etc., and also to control as far as possible certain organic fluctuations which affect efficiency either in limited or in more general respects. Often the cause of such changes in efficiency are hard to ascertain, and about all that can be known definitely is that the subject is having a "bad" or a "good" day. For our present purpose, we may accept in a general way Hunter's characterization of learning, and "say that learning is taking place wherever behavior shows a *progressive change,* or *trend,* with a repetition of the same stimulating situation and where the change cannot be accounted for on the basis of fatigue or of effector and receptor [or other organic] changes" (53, p. 564).

With this tentative definition in mind, we may indicate in a preliminary manner some of the special characteristics of learning by children: (*a*) Young children are undergoing rapid growth or maturity changes which are not to any appreciable extent due to specific practice—changes in neuron development affecting synaptic connections, as well as changes in the strength and balance of muscles, changes in glandular development, etc. (*b*) Children become fatigued more quickly or lose motivation for most specific tasks more rapidly than do adults, and their motivation comes more largely from stimuli by immediately external or inner factors than from such remotely oriented "sets" to large circumstances as are usually found in adults; they are, for example, freer from financial, professional, and social cares, and hence capable of more whole-souled occupation with any immediate problem-situation presented, if it is not so complex or difficult as to involve remote factors. It is well known, however, that the infant makes remarkable progress in general orientation, walking, the use of language, etc., these acquirements being strongly motivated by metabolic changes and immediate external conditions which serve to limit or facilitate

activity. (*c*) Children's behavior, in earlier stages at least, is far less tied up by such proprioceptive connections as have been set up in adults by chain or serial responses, by means of which one response immediately excites the next one without further external stimuli. Children are therefore more plastic so far as adaptation to present environment is concerned. (*d*) Infants do not at first have the so-called voluntary controls, based on cultural stimuli (43*a*). In very young children no vocal-auditory controls of activity have been set up by social stimuli, so infants must be controlled and directed in experiments by methods more like those used with animals than with adult humans, yet they do not have the well-developed "action systems" found in adult animals.

Modern Objective Methods of Studying Infants' Responses

In the more recent study of child behavior much attention has been focused on objective methods of studying motor coordinations and specific performances. Much of the recent improvement in technique has come about from work on tests of various kinds. Norms have been set up both for physical and mental growth with the advance of age. These norms seem to serve two main purposes: (*a*) that of building a general body of knowledge as to the nature of growth itself, and (*b*) that of being guides in the study and treatment of special cases. Neither of these purposes is *necessarily* related to investigations in learning, but the by-products of such investigations make advancement in experimental methods of studying child learning inevitable.

Recent objective studies by Minkowski (51), by Pratt, Nelson, and Sun (70), by Irwin (39), and others of the child's early movements and responses to definite stimuli under controlled conditions have made a good beginning toward continuous observations and experimentation on the behavior of a considerable number of infants; and they have revealed a remarkable amount of "mass activity"—poorly coordinated activity involving the entire organism—in human fetuses and newborn infants. This activity has been shown to take place because of stimuli from inner metabolic changes even when external conditions were kept constant (Irwin). It has been found to become more and more replaced by specific reactions with the advance of the individual's age and general exercise.

The Specialization of Responses. How this specialization of responses is effected is a problem that has been studied by Boeke (7), Minkowski (51), Child (14), Coghill (15), and others, some of them experimenting with lower forms of animals. Child has considered physiological gradients in energy transmission as precursors of nerve fibers, and Coghill, working on the Amblystoma, has shown a remarkable degree of parallelism between the development of neurological mechanisms for more and more specialized behavior and the corresponding differentiations in behavior. He made detailed neurological studies, on the one hand, and motion pictures of

behavior at different stages (rate of the camera being about 17 pictures per second), on the other. He found that branches of nerve fibers to the large trunk muscles, which effect the larger side-to-side head and body movements proceeding tailward, grow on beneath and beyond muscle segment and invade the territory of limb-forming tissue even before the muscle tissue is formed there. "As a result of this precocious invasion of limb-forming tissue by branches of nerve cells that are already integrating the trunk, the earliest movements of the limbs are of necessity totally integrated with trunk action" (15, p. 22). Thus the development of local parts early becomes regulated by the large orientation mechanisms, and their movements become directed by the general organic adaptations; but later they come to respond more and more definitely to local exteroceptive stimuli and to gain specialization and independence of their own, never, however, having complete autonomy.

Some Observations and Experiments on Infant Coordinations and Learning

Brainard (8) has made daily observations on learning in his own daughter, Ruth, supplemented by observations of other infants. He finds that the position generally assumed by the fetus, of having the hands hugged together under the chin, is characteristic of many infants "for several weeks" after birth, although at this time the hands are released. Ruth's hands, partly closed, moved at first in a spasmodic manner and at random. The next few days the arms moved rather more freely and through a wider arc, especially under hunger and other inner excitations. On the fourth day they accidentally touched the mouth. This at once brought about head movements toward the nipple, and the thumb of the right hand, which was protruding, went into the mouth. This occurred also on later days, though often the random movements were so large as to pull the hand out of the mouth. The right hand had a tendency to move to higher points than the left hand, and gradually the sucking of the right thumb became a somewhat specific habit. The left hand did not move high enough to get into the mouth, except when the right hand was held. The adjustments of the right thumb to the mouth and of the mouth to the thumb gradually improved. "At the end of the second month the fist would be doubled but the thumb stuck out and moved directly to the mouth" (p. 232). These observations leave much to be desired both in accuracy and in objectivity, and some of Brainard's interpretations are tainted with a teleological interaction view. *What* specific movements appear and *when* is in itself of little value: it is the mode of establishment of the larger integrations that is important. Goodenough (25) has shown that for reliable data on child behavior one must make observations and tests under so diverse conditions that they constitute representative samples of the child's total daily behavior, and that proper understanding of development in one sort of function or activity is impossible without simultaneous data on the development of other

functions. Thompson (78*b*), from a detailed analysis of the growth of behavior in an infant, reports that behavior growth advances fully as rapidly as physiological growth, and manifests itself in (*a*) greater frequency in one item of behavior, (*b*) improved performance of an activity, (*c*) the appearance of new activities, and (*d*) integrations of activities. The record of any one activity is an inadequate indication of the real development.

Curti (17) has recently published data on the decrease in apparently superfluous acts by a baby after the one-hundred-twenty-eighth day of age. A rattle was held six inches directly above and in front of the infant for one minute in each trial and was shaken intermittently so as to give both auditory and visual stimulation. Since it had been noticed previously that such a situation produced in the infant much diffused activity, like movements of body, waving of arms, and kicking of the legs, the kicking movements were chosen as the focus of observation. While the trials were apparently designed to occur once each day, the rattle seems, unfortunately, to have been presented out of experimental periods "several times a day." The baby seems therefore to have had an indeterminate amount of practice in inter-test periods. The rate of decrease, however, beginning when the child was 129 days old, is shown in the following number of kicks per minute in trials on successive days: 70, 37, 42, 25, 13, 24, 6, 8, 3, 5, 3, 2, 1, 1. The notes recorded during the first trial indicate (with only one exception) "steady fixation with very intent look," and refixation when the rattle was again shaken. There was a great deal of diffuse ("mass") activity, including "eager grunting sounds." "About three" times the arms were brought toward the center, nearly meeting. In successive trials these excess movements gradually decreased, so that "the infant who at the beginning of the experiment was a squirming, wriggling, excited little animal when the rattle was presented, had in a week's practice learned to grasp the rattle promptly with a minimum of general bodily movement" (17, p. 169). Adults, when learning new coordination in acts of skill, reveal very similar initial, excessive activity, with gradual elimination of such activity as practice proceeds (cf. Swift, 78, Chap. 6; Peterson, 56; Batson, 3).

The Shermans (74) in 1925 published data from a study of ninety-six infants, at a beginning age of one-half hour, on the improvement through early ages (*a*) in the responses of the pupil to light, (*b*) in sensitivity of the legs and face to the prick of a pin, (*c*) in the coordination of the eyes in following a light, and (*d*) in the coordination of the arms in defense reactions to pressure of the observer's forefinger on the chin when the infants were held with the back on a table, head steady. Marked improvement occurred up to "perfect" responses for case (*a*) in a little over one day, for (*b*) in less than two days for the face and in about three and one-fourth days for the leg, but for (*d*) it took over twelve days for a "perfect coordination" in approximately four successive trials. In this last case (defense reactions) the number of arm movements for each perfect co-

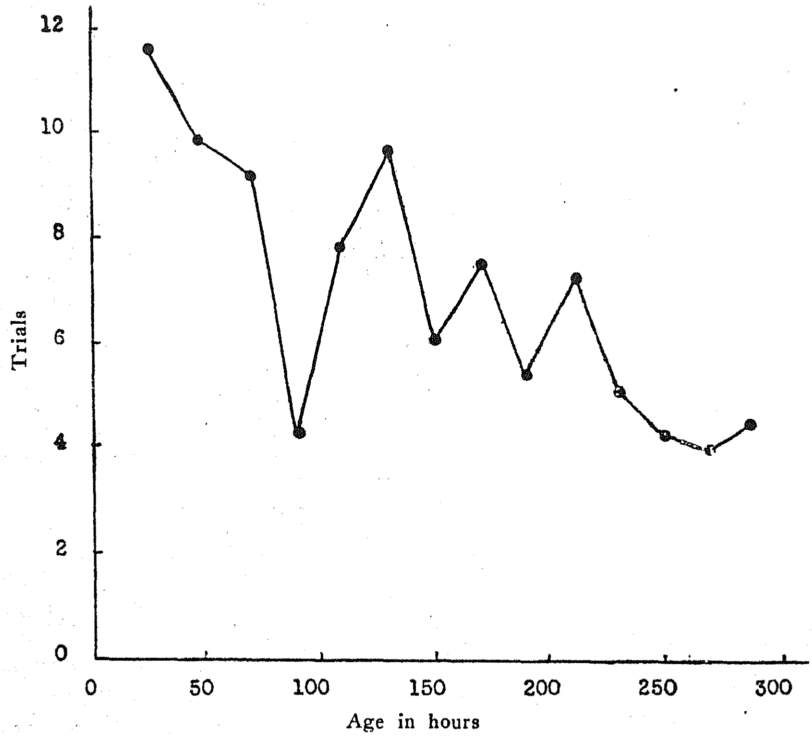

FIGURE 1

Number of Trials Necessary at Different Ages for a Coordinated Defense Movement of the Arms in Response to Pressure on the Chin

(Modified from M. Sherman and I. C. Sherman's "Sensori-motor Responses in Infants." *J. Comp. Psychol.*, 1925, **5**, 66.)

ordination (i.e., one in which both of the infant's hands touched in a pushing motion the distal part of the examiner's finger at the chin) was recorded. The curve of improvement with age in this latter case is shown in Figure 1.

Improvement in such cases is due to both practice and maturity. It is unfortunate that the authors did not, at the age levels tested in (*d*), use controls (infants without previous practice), and that details as to number of cases tested at each age and the amount of earlier practice on these tests are not given. (No infant below twenty-one hours of age made a successful defense movement.)

Maturity versus Training in Infant Learning

Gesell and Thompson (24) have attempted to evaluate the relative contributions of maturation and training by a study of identical girl twins, *T* and *C*. At the initial age of forty-six weeks, *T* was given six weeks

of daily training (20-minute period per day) in block manipulation and in the climbing of stairs, while *C* served as a control and had no specific training in these reactions. At fifty-three weeks, however, *C* was trained for two weeks in climbing. Observations recorded stenographically and by motion pictures were the chief data used to note effects of training. At fifty-two weeks, after six weeks' training, *T* climbed the stairs in 26 seconds; whereas *C*, at the same age, with no specific training, required 46 seconds. Two weeks later, *after* practice, *C* climbed the stairs in 10 seconds. *T*'s record at fifty-four weeks is not given. The procedure with the control twin is open to question, and the statement of results is too qualitative for exact comparisons. No significant effects of the training were found, and the authors judge that "maturation plays the primary rôle and preserves the generic aspects of behavior patterns." Differences in specific training (both *T* and *C* had general undirected practice) were probably too slight for results of the type sought for. This "method of co-twin control," as here illustrated, is certainly in a rather formative stage of development and has many uncontrolled variables.

In the case of lower animals, experiments of this sort are more easily carried out with proper controls. Breed (10) and Shepard and Breed (73) have attempted to isolate maturation and practice effects in the accuracy of pecking by young chicks. They kept the chicks under conditions of darkness, which made practice at pecking impossible or improbable, and fed them artificially. Liberating groups of chicks at different ages up to five days, and studying their learning curves based upon scores assigned by an objective method, they found in general (*a*) that the chicks which were more mature at the beginning of their testing advanced more rapidly up to the normal level of efficiency of practiced fowls than did those that began practice on the first day after hatching, but (*b*) that, in any case, practice was essential for the appearance of accurate movement. The second of these conclusions has been supported in later work by Bird (5) and by Moseley (52), but Moseley's results contradict Breed and Shepard's in showing a high negative relation between rate of learning and age (1, 3, 6, 11 days) at beginning of practice. On this latter point the evidence is, then, inconclusive. It is an important problem in the learning of children.

The Acquisition of Skill in Young Children: Maturity Influences

A study in the acquisition of skill in young children, also bearing on maturation effects, has recently been carried out by Hicks (32, 32*a*). The problem was to ascertain to what extent younger children improve in complex motor skills as a result of specific practice and to what extent other factors, such as structural maturation and general practice, are effective in the increase of skill in specific functions. His work is based on a study of sixty children, distributed according to sex and age at the

TABLE 1
AGE AND SEX CLASSIFICATION OF SUBJECTS

	Boys		Girls		
Years of age*	Practice group	Control group	Practice group	Control group	Total
3	2	2	4	4	12
4	4	4	5	5	18
5	3	3	6	6	18
6	4	4	2	2	12
Totals	13	13	17	17	60

*Three years includes two years and beyond six months to three years and six months, etc.

beginning of the experiment, and paired equally into a control group and a practice group as shown in Table 1; the members of the latter group were given specific practice in throwing a ball at a moving target, while those of the former had no such practice.

The moving-target test was the main test in this experiment.[1] The target was a white circular disc, 4 feet in diameter, and was so constructed as to move along a horizontal track for a distance of 10 feet, at a constant speed of .33 foot per second. In its center was a green bull's eye, 7 inches in diameter. The background was black. The target was so constructed as to carry a carbon sheet next below the outer record sheet of newsprint paper, carbon outward, so that when the ball hit the target a record of the place hit was automatically made. It was started, stopped, and reversed by means of electric switches. Squash tennis balls, 2.25 inches in diameter, were used. The child stood 5 feet out from the center of the running path of the target on an adjustable 6-foot-square platform, so set for each subject that the center of the green bull's eye was one inch below the height of the child's shoulder.

Each child was at first properly instructed and interested by seeing the target move and hearing the bell ring when the bull's eye was hit. Whenever the target was hit, it stopped automatically, and the distance it had gone from the starting-point was measured on a tape fastened to the upper guide line. The exact place of the hit was marked with a pencil and numbered. The child was encouraged on each preliminary throw of the initial test and on the first throw of the practice period, and was praised at the end of the periods; but no instruction was at any time given as to the ways of improving his skill. He was told, "Now I'll make the target move," and was left to throw when he was ready. The complete record contained (*a*) the distance the target moved before being hit, (*b*) the hand used by the child in throwing, (*c*) the manner of throwing, (*d*) observational notes, (*e*) the distance from the center of the target

[1]The Blanckhurst (6) arm-strength test, the Wellman (86) tracing-path, and the perforation test (Baldwin and Stecher, 2, pp. 95-98) were also given as supplementary motor tests, both at the beginning and at the end of the throwing experiment (Hicks, 33). See results on p. 426.

to the place hit by the ball, (*f*) the score (25 inches *minus* the distance in item *e*), and (*g*) the angle of direction of the point hit from the center of the target.

The thirty children of the practice group were all given individually three preliminary throws, and then ten other throws in the initial series; then, on every succeeding week, each child at his own assigned time of day was given one practice period of ten throws each for eight successive weeks. At the end of this period and at his usual hour, he was given, likewise on successive weeks, two end-tests, E_1 and E_2. The total practice of each subject in this group, aside from the three preliminary tests of the initial practice period, was thus eleven periods or 110 throws. The children of the control group were given only the initial and end-tests, with an omission of the eight regular practice periods, but the end-tests came, as for the practice group, on the two weeks after the eight weeks, so that the distribution of the initial and end-tests was the same for all sixty children. The reliability of this whole test, as determined for the sixty children at all the ages represented, was .94, as computed from the scores on the odd-even throws and the Spearman-Brown up-step formula. For the 30 three- and four-year-olds it was .86, and for the 30 five- and six-year-olds, .78. The correlation between the initial test and the first practice test (30 subjects, all ages) was $.74 \pm .06$.

Space does not permit the reproduction of the author's detailed data, but in Table 2 are given, with certain other data, the mean scores and the standard deviations (σ's) of the distributions of the two sexes in each group when all ages were combined. Since the sexes and number of cases are equated in the two groups for each age, these results are sufficient for our purpose. It will be noted that the two groups start out with exactly equal scores in the initial test of ten throws for each child. In the ten practices (from the middle of the initial to the middle of the second end-test period), with a total of 100 throws, the practice-group children as a whole gained 1.9 score points $(13.6 - 11.7)$, and the control group, 1.3. This difference between initial and final score is reliable for the practiced group but unreliable for the control group. The difference between the two gains is unreliable, showing an uncertain effect of the intermediate practice of eighty throws.

In the practice group the males gained 5 per cent on the one hundred throws between the initial and E_2 tests; the females, 30 per cent; and both sexes together gained 16 per cent. The corresponding gains in the control group on only twenty throws (half of the 10 on the initial test, all the 10 on the E_1 test, and half of the 10 on the E_2 test) are 1 per cent, 23 per cent, and 11 per cent. It will be noted that, although the boys, as the author states, were in all age groups but one—the five-year control group—from .7 to 4.5 months younger than the girls, they considerably excelled the girls. This is shown in the ratios of mean scores by females to those by males, which we have added to the table. This superiority of males over females exists—as the author's table shows—in all ages of both

TABLE 2

SHOWING COMPARATIVE RESULTS IN MEAN SCORES AND STANDARD DEVIATIONS FOR THIRTY CHILDREN IN THE PRACTICE AND THIRTY CHILDREN IN THE CONTROL GROUP (ALL AGES COMBINED)

A "score" is 25 minus the distance hit from the bull's eye.

Group	Sex	Number	Initial Mean	Initial σ	1 Mean	1 σ	2 Mean	2 σ	3 Mean	3 σ	4 Mean	4 σ	5 Mean	5 σ	6 Mean	6 σ
					Tests and practice periods											
Practice	Male	13	14.0	5.2	13.0	4.2	12.3	4.4	12.1	4.5	13.5	4.8	13.6	3.2	14.2	3.8
	Female	17	9.9	5.2	10.0	4.9	10.6	4.6	12.1	5.3	9.6	4.0	11.3	3.5	10.3	4.2
	Both	30	11.7	5.7	11.3	4.7	11.3	4.6	12.1	5.0	11.3	4.4	12.3	3.8	12.0	4.5
Control	Male	13	14.0	5.3												
	Female	17	9.9	5.1												
	Both	30	11.7	5.6												

Group	Sex	Number	7 Mean	7 σ	8 Mean	8 σ	End₁ Mean	End₁ σ	End₂ Mean	End₂ σ	Mean of all	Percentage gain by practice
			Tests and practice periods									
												(100 throws)
Practice	Male	13	15.2	3.3	14.6	3.3	14.3	3.1	14.6	3.3	13.8	5
	Female	17	11.2	3.0	11.5	3.1	11.7	2.8	12.9	2.7	11.0	30
	Both	30	12.9	3.6	12.8	3.5	12.8	3.2	13.6	3.3	12.2	16
												(20 throws)
Control	Male	13					14.4	4.2	14.1	3.6	14.2	1
	Female	17					11.3	3.7	12.2	3.5	11.1	23
	Both	30					12.6	4.0	13.0	3.7	12.4	11

Group	Ratio	Initial	1	2	3	4	5	6	7	8	End₁	End₂	Mean of all
			Tests and practice periods										
			Ratio of means										
Practice	Female to male	.71	.77	.86	1.00	.71	.83	.72	.74	.79	.82	.85	.79
Control	Female to male	.71									.78	.86	.78
			Variability										
Practice	Both sexes (N=30)	.49	.42	.41	.41	.33	.31	.38	.28	.27	.25	.24	
Control	Both sexes (N=30)	.48									.32	.28	

groups except in the case of the four-year-olds of the control group, and may therefore be regarded as significant. There is no reliable tendency in either group for the females to gain or lose in this comparison with advance of age from three to six years. Here, then, is a sex difference in this performance which reverses what is usually found in mental and school achievement tests. Is this superiority of the boys at ball-throwing due to earlier general experience or to innate factors? We do not certainly know, probably it is a function of both conditions. At any rate, it is clear, from the percentage of gain given above, that, when the children were given no suggestion as to methods of improvement, the girls gained more by practice than the boys, indicating either a less practiced condition at the start (cf. Peterson, 63), which would mean that the sex difference is due only to practice, or to greater wisdom on the part of the girls in discovering methods of improvement, or to a combination of these. The gains by the children of the several ages represented in both the practice and the control groups are shown in Table 3, where it is evident that the

TABLE 3
PERCENTAGE GAIN ACCORDING TO AGE

Group	Number of practices	Age in years 3	4	5	6
Practice	110	117	10	11	6
Control	10	52	10	14	4

younger children gained more than the older ones and also that the children above three years of age gained no more as a result of the one hundred throws than as a result of ten throws. These data are very interesting and, in certain senses, puzzling, since the results of the throws were visible and should have been taken advantage of more by the older than by the younger children. They suggest that maturity plays a great rôle in accuracy. The increase from initial to final test (three months later) in strength and perforation scores (33, p. 297) support this conclusion, but tracing ability decreased in this interval.

Several problems for future investigation are raised by the results of this study. It is interesting to note that at all ages in both groups the standard deviations (σ's) decreased perceptibly with practice, even though the means on the whole increased; the practice effects thus made a considerable reduction in individual differences as measured by the coefficient of variability through the short period of ten weeks. The results of all ages combined (rather typical of the children of the several ages) are given in the lower part of Table 2. In the practice group the variability coefficient changed from .49 to .24 in one hundred throws, and in the control group it decreased from .48 to .28 in ten throws, only a little less. The significance of this decrease in variability and of the small difference in decrease during this period between the two groups under the conditions is not clear from the data at hand.

By similar procedures Hicks and Ralph (33*a*) found, with twenty-four children (20 to 40 months of age), that the considerable improvement in tracing the Porteus diamond maze by the practice group (scored objectively by a superimposed isinglass model that divided the tracing into 44 equal segments) was equaled by the improvement of the control group. Aside from the equal initial and end-tests given both groups, the practice group had two additional trials each week for seven weeks. Hilgard (34*b*) has reported similar results on ten two-year-old children, matched initially in CA, MA, sex, buttoning, cutting with scissors, and climbing. Twelve weeks of "intensive training" by the practice group in the three activities named yielded no reliable group differences on the four-day end-tests.

Jersild (39*a*), experimenting on over two hundred children of ages two to eleven years, distributed for work on different problems, has investigated the effects of specific training on rate of tapping, strength of grip, strength of back, vital capacity, color naming, free association, and ability to reproduce tones and intervals. Standard methods—pairing children in the control and the experimental groups and giving initial and end-tests to both groups, giving specific training (mostly three days each week) to the practice group for several months—were used, and retests were also given to both groups several months after training had ceased. The brighter children individually profited more by practice than the duller ones, but with the exception of the last-named test no differences of paired groups persisted through the retests. The effects of the training in singing of pitch and interval were "more pronounced and decidedly more permanent" in the practice group than in the controls. In this training, the author points out, the child had an opportunity to add new items, such as singing new pitches and new intervals. Whether this is a final explanation can be settled only by further experiments. The recent results by Cook (15*a*) on 110 children one and one-half to six years of age, showing that ability in matching color hues (R, G, Y, and B) increases rapidly from two to four years, when maturity is practically reached, indicates enormous maturation effects in certain child activities; but there are certainly also some very specific training effects in other activities. D. P. Marquis (45*c*), for example, has shown by objective methods on eight artificially fed newborn infants that normally conditioned mouth-opening, sucking, and other responses, as well as cessation of irrelevant movements (crying, excess activity), could be established in four or five days to the sound of a buzzer.

D. G. Marquis (45*b*) has divided environment into three classes; intracellular, intercellular, and external to the organism, and has pointed out the remarkable constancy of the first two and the delay in any influence on them by changes in the third. The embryo, moreover, is further protected, as a rule, from outside influences by being located in a safe place during development. These protective inner environments—constant temperature, optimal concentration of liquid media, and physical protec-

tion—which are due to complex mechanisms and interorganic processes, and which are really not directly (in the life of the new organism) produced by external factors, he calls *beta* inheritances. He defines *maturation,* then, as development effected by interactions of the organism with its inner environment. This conception reduces somewhat the absolute notions frequently implied by the terms "heredity" and "environment." Shirley (74*a*), who presents evidence for an organismic view of progressive differentiation of particular responses out of more general and basic activities, has suggested a "sequential method" for tracing definite successions in the appearance of behavior patterns in correlation with the maturation of bodily structures, and independent of social, racial, and intellectual influences on the child. Confirmatory evidence from an investigation of the rôle of maturation in infants and with data from other sorts of studies is offered.

Effects of the Distribution of Practice in Acquiring Skill in Dart-Throwing

Long (45), working under the writer's direction, made a study of the acquisition of skill in dart-throwing by two groups of sixth-grade boys, ten in each group, the mean ages being $12.25 \pm .12$ and $12.40 \pm .11$ years for Groups I and II, respectively, at the beginning of practice. The targets were sheets of heavy Manila paper with three concentric circles, 20, 40, and 60 cm. in diameter, and a bull's eye of 2-cm. diameter at their center. These sheets were tacked to a background of Celotex, 6 feet square, fastened to the wall of the practice room. The darts were standard darts made by the Apex Manufacturing Company and were 7 inches long, each one weighing approximately .75 ounce. Each of the boys of Group I made twenty throws two days a week through fifteen practice periods, and each one of Group II made ten throws four days a week through thirty practices (a total of 300 throws by each subject). Interest was good throughout the practice. Group I practiced at 9:30 and Group II at 10:30 A.M. Precautions against outside practice were taken, and careful investigations revealed no such practice. Each boy threw the darts at the rate of approximately one every five seconds as the experimenter counted seconds from one to five. This five-second period was decided upon in preliminary trials. The only instructions given were to "try to hit the bull's eye." At the end of each series of five throws the places hit were numbered in order. When the practices were ended each day, the experimenter measured in centimeter-units the distance of each hit from the center of the bull's eye, recording the score thus in terms of errors. The boys were given their respective scores in terms of a more practical scale after each practice, and the two group medians were occasionally compared.

Reliability of ranks on total scores (300), found by correlating ranks on the basis of means in the first and the second series of ten throws and using the Spearman-Brown formula, was $.976 \pm .010$ for Group I and

TABLE 4

MEAN ERROR FOR EACH PRACTICE PERIOD

Group I made 20 throws every other day; Group II, 10 throws daily. Each number is the mean of 100 throws: 10 subjects, 10 throws each.

Successive 10-throw periods	Error in mm. Group I	Group II	Successive 10-throw periods	Error in mm. Group I	Group II
1	198	253	16	172	203
2	212	249	17	170	224
3	210	216	18	182	187
4	215	218	19	178	192
5	180	235	20	160	170
6	192	200	21	186	188
7	172	227	22	176	215
8	169	239	23	179	202
9	190	186	24	187	184
10	192	218	25	189	175
11	204	232	26	165	200
12	184	218	27	181	166
13	182	227	28	169	170
14	170	182	29	166	157
15	180	179	30	160	176

.930±.029 for Group II. The mean error scores in successive ten-throw series are shown for the two groups in Table 4, and are represented graphically in Figure 2. Gradual improvement by both groups is evident, Group II making the greater gain. Group I improved 17 per cent from the middle of the first series of fifty throws to the middle of the last fifty, whereas Group II improved 26 per cent. The geometric mean of improvement by Group I through five series of fifty throws each ($\sqrt[5]{M_1/M_6}$) is 4 per cent, as compared with 6 per cent by Group II. In the first series of fifty throws 73 per cent (by actual count) of the scores of Group I equal or surpass the mean score of Group II; in the last series of fifty throws this percentage has decreased to 60. The corresponding percentages for the first and last one hundred throws are 66 and 58. These data all agree in indicating greater progress for Group II with better distribution of practice. The results agree with effects of distributed practice as generally obtained in adults by Dearborn (20), Starch (75), Pyle (71), Lashley (43), Peterson (56), and Pechstein (55). Murphy (54), however, found ten throws daily superior to five twice a day.

Long (45) obtained a coefficient of variation ($V = \sigma/M$) of .233±.016 in the first fifty trials and .248±.019 in the last fifty for Group I, and .270±.018 and .292±.019 for Group II. There is a slight, but not reliable, indication that practice increased the individual differences in both groups. This tendency is in the same direction for both groups, and agrees with Murphy's results on dart-throwing by twenty senior normal-school girls, as similarly calculated by Peterson and Barlow (65); but Kincaid (40) found an opposite tendency in twenty-eight college students.

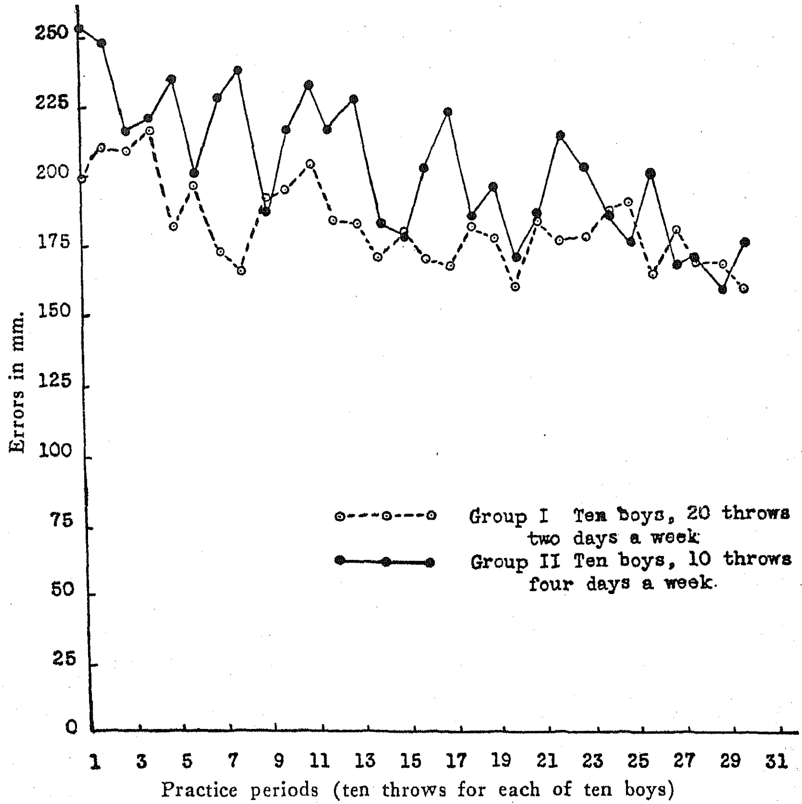

FIGURE 2

SHOWING DECREASE IN ERRORS IN SUCCESSFUL PRACTICES

Each point in a curve represents the mean of one hundred throws.

EFFECTS OF INSTRUCTION AND GUIDANCE ON LEARNING TO THROW ROPE-RINGS

In an experiment on throwing rope-rings, 7 inches in diameter, over a post at a distance of 4.9 feet, Goodenough and Brian (26) studied analytically the effects of instruction and guidance on the acquirement of motor skill in 20 four-and-a-half-year-old children. Each child was allowed twenty throws daily for fifty days as nearly in succession as was possible in view of week-ends and other absences. The post was at the center of two concentric circles, 24 and 48 inches in diameter, respectively, and two lines were also drawn on the floor at right angles to each other, one passing through the position occupied by the child while throwing. Mimeographed miniature duplicates of the floor-plan were used for recording the location of the point where the rings hit and the order of each hit in the child's series of twenty throws each day. While "successes"—throws resulting in

placing the ring around the post—were the main data used, unsuccessful throws, classified roughly as to position of striking within the several quadrants and circles, descriptive notes by the experimenters as to method of holding and throwing the rings, and other circumstances of the responses, as well as records of the children's comments and criticisms of their own throws, were used as aids to interpretation of the results. This all-or-none method of scoring was found by a special study to give a higher reliability (.93 for the total performance through fifty days) than did other methods tried. The general conditions under which the throws were made, together with the perception of results of each throw, assured good motivation; but additional sources of motivation were utilized also, such as allowing each child to post on a wall-chart by his own name one sticker (gold stars, Christmas seals, etc., each kind being used on given days) for each "ringer" thrown by him.

The children were divided into three groups: Group A consisted of four boys and six girls who were given no instructions whatever as to the manner of throwing, but were praised and encouraged; Group B, of two boys and four girls who were given a brief preliminary demonstration and instructions and subsequent constructive verbal criticisms and suggestions, such as "not quite so far next time," but who were not required to adhere to any particular method of holding and throwing the rings; and Group C, of two girls and two boys who, in addition to demonstrations and instructions given to Group B, were taught to follow a definite procedure "and were not allowed to experiment with other methods." The three groups were approximately equated as to amount and distribution of practice, as to age, and as to intelligence test scores. All individual records and curves of results show considerable inconsistency from day to day. Little or no gain was made by some individuals in Groups A and B. The mean absolute gains in "ringer" throws in the second twenty-five throws over those in the first twenty-five were 11.5, 17.5, and 42.5 for Groups A, B, and C, respectively. The corresponding percentage gains were 36, 56, and 92. It is unfortunate that the groups were so small as to leave uncertainties regarding the reliability of this marked superiority of Group C, which practiced under constant criticism and direction of the experimenters. The data show efficiency in results directly in proportion to the instruction of the learners. The curves of the mean scores by each group, shown in Figure 3, indicate that all three groups, when stopped on the fiftieth day, were at a stage of marked improvement, Group C being considerably in the lead of the others. Progress on so complex a motor activity as this is usually slow and gradual both in adults and in children. Correlations of the total scores on the first ten days with the gains over those made on the last ten days, corrected for effects of errors of measurement by Thomson's (79) formula, are —.197, —.487, and .029 for Groups A, B, and C, respectively; for all the groups combined, the correlation was —.055. These results agree, in general, with motor-learning studies on adults. Negative or zero correlations were also obtained between the weighted

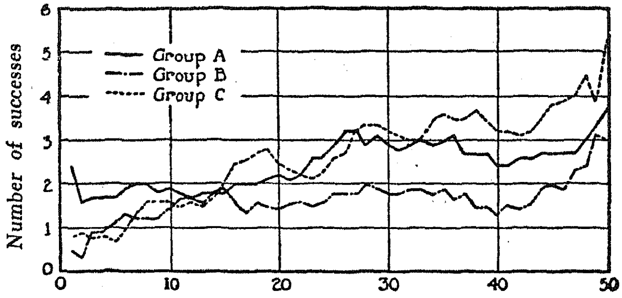

FIGURE 3

CURVES OF MEAN PROGRESS BY GROUPS A, B, AND C, RESPECTIVELY

(From F. L. Goodenough and C. R. Brian's "Certain Factors Underlying the Acquisition of Motor Skill by Pre-School Children." *J. Exper. Psychol.*, 1929, **12**, 134.)

mean of the scores on three to seven standard intelligence tests and the total successful throws during the fifty days of practice; and similar coefficients were obtained in correlating intelligence scores with *gains* in successes in the second over the first half of the entire practice. Intelligence tests had, therefore, practically no predictive value for degree of success either in scores or in improvement by practice [results resembling those found on adults by Atkinson (1*d*)]. In every group the boys surpassed the girls. The mean score of all the boys was 141, as compared with 91 for the girls, a difference that is probably significant; but the girls improved slightly more than the boys on the last ten over the first ten days' practice, probably due to their being less practiced in such performances at the beginning of the experiment. A study of the successes by all the children in the first, second, third, and last five trials of each day's practice shows regular improvement throughout each day's practice. Unfortunately, this improvement is not compared with improvement, if there be any, *between* the practice periods on the successive days, to determine whether learning also took place while the children were *not* practicing. An analysis of errors shows a reliably greater tendency in the children to throw beyond the mark in the trials immediately following success than in all other unsuccessful throws, indicating the stimulus effects of a child's seeing his successful throw. The degree of this tendency showed a small positive correlation (.325) with teachers' ratings of emotionality in the child. Analyses of individual records revealed a tendency in the children of Groups A and B to vary their procedures without sufficiently testing each procedure and also indicated that any regular plan of distribution of practice is probably less valuable than one which would allow "appropriate interruption of practice at times when the setting up of undesirable habits appears to be retarding progress" (p. 155).

Transference of Learning

Age and Transfer Effects in Stylus-Maze Learning. Esther McGinnis (48) compared the learning ability of three-, four-, and five-year-old children in stylus-maze learning, transfer and interference being the special objects of study. The Young Slot Maze (91), constructed after Carr's (13) method, so that the stylus can be removed from the board only at the end, was used. A boy clown (toy) stands at the end of the course as a goal, and the stylus is a round disc on which is mounted a toy shoe. The child is instructed as follows:

> "See this boy? (Pointing to the boy). This (grasping the shoe) is his shoe. The boy wants his shoe. I want you to take it to him. See how quickly you can take the shoe to the boy."

The experimenter allows five minutes. The child, during this period, is urged as needed. Every subject had five consecutive trials on five days each week for two weeks, fifty trials in all. Twenty children, divided equally as to sex, were in each group at the beginning of the experiment, but absences disturbed somewhat the regularity of the practice. The children were severally informed as to the time required within the limit allowed. Reliability of time scores in trials 5-50 for the entire sixty children (odds-evens method) was found to be $.62 \pm .02$. Results in median seconds for successive five-trial periods for each age group are given in Table 5 and Figure 4. The differences on both the initial and the final trials are reliable only between the three- and the five-year-olds, but all are in the same direction, favoring older groups (author's Table 10, p. 246). There is no evidence, of course, that the children were held to maximum, or even to equal, motivation at different age levels. Sex differences are unreliable. Correlations between IQ's and the learning-efficiency criteria (both time and errors) are nearly all positive, but most of them are unreliable, showing no very high relationship of efficiency and intelligence, when age is controlled. The highest is $.66 \pm .12$ for the four-year-old boys on total errors, and $.60 \pm .14$ on total time. In the other cases no correlations exceed .42. In all cases practice decreased the coefficient of variability ($V = \sigma/M$) from the first to the last trial, and the lower fourth improved more than the upper fourth—results usually found on adults.

In a further study, twenty-four children were matched as to sex and paired as to approximate equality in age, mental age, and initial and "best" trials on the Young Slot Maze; and they were put through successively (in different orders) other stylus-maze forms for detailed study of transfer effects. Electrical connections for bell-ringing at the attainment of a goal were made for purposes of motivation. In every case, regardless of the order in which the different maze patterns were given, marked positive transfer occurred. This was true even in cases of mazes presenting opposite-direction movements at certain turning-points. No "interference," except of a temporary nature between the last trial of one maze and the

TABLE 5

SHOWING THE MEDIAN SECONDS OF EACH GROUP FOR SUCCESSIVE FIVE-TRIAL PERIODS IN STYLUS-MAZE LEARNING

	Successive groups of five trials each									
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
3-year-olds	122.9	40.4	35.0	32.0	29.9	27.9	24.1	23.7	22.7	19.4
4-year-olds	90.2	34.7	27.3	27.8	24.3	22.5	23.6	21.5	22.0	18.5
5-year-olds	42.4	23.3	20.3	18.5	18.7	16.1	16.5	16.1	15.1	14.7

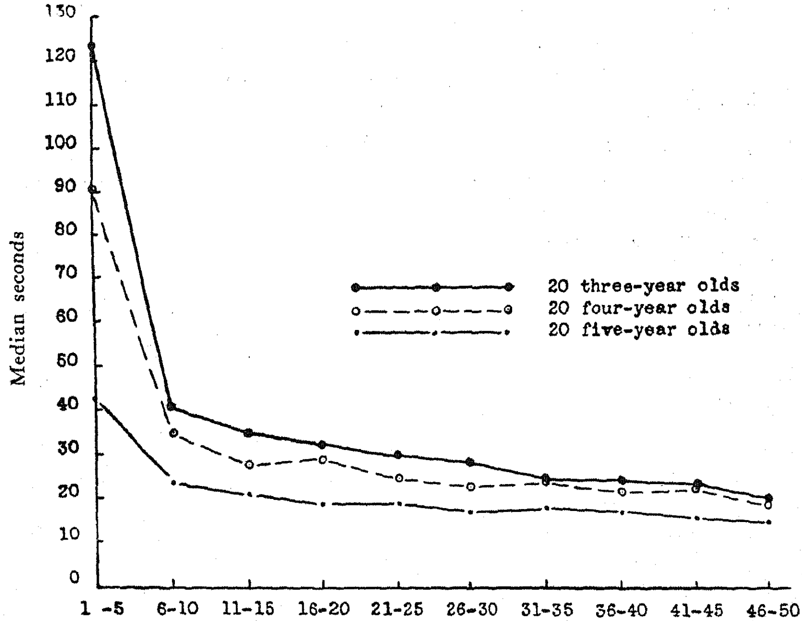

FIGURE 4

MEDIAN SECONDS FOR TRACING THE MAZE BY THE CHILDREN OF THE THREE AGE GROUPS INDICATED

first of another, was shown (at least no cases of hindering habits outweighing facilitating habits), so that the maze ability measured increased from maze to maze, as found by Webb (85) for rats. Unfortunately, the work did not enter into the important question of relations of degree of transfer and intelligence.

Bilateral Transfer Effects. Wieg (86*a*) has traced studies and theories on bilateral transfer of learning and has carried out an experiment on twenty-four boys and twenty girls, ages sixty-six to eighty-eight months, in which children were grouped into sets of four, equated for age, IQ, socio-economic status, sex, and tracing a relief maze. Each of the four S's in any set learned to trace the maze with a different limb. The criterion

for learning was not more than two errors for three trials. Transfer was tested for each S from the practiced to a non-practiced limb by means of initial and final tests, and also from the practice maze to a mirror-image maze. Results show that improvement both in speed and in the number of trials required to learn the maze decreases with age and experience. Greater speed was obtained when the limb used begins to trace at its own side of the pattern. Better positive transfers were always obtained when going from the less efficient to the more efficient limb, efficiency here referring to scores on initial trials; and transfer improved with age. There is indication that "early emphasis upon accuracy for the purpose of developing necessary caution may be the best practice in motor learning," and that "where transfer in motor learning is desired, training of the least efficient limb is most economical" (p. 267). Some of these important aspects of the results need further investigation with better control of irrelevant factors and more penetrating analysis.

Morsh (51*a*), in an experimental study carried out over a period of five months on two left-handed girls (one, twelve years old, in the eighth grade; the other, nine, in the fourth grade), has found considerable improvement of right-handed skill in tracing, target throwing, mirror star-tracing, and writing. He avoided calling attention to the girls' left-handedness and averted embarrassments associated with that tendency. No evidence of stuttering tendencies was noted. He holds that success in such changes of handedness is assured if an early start is made and if by tactful and patient methods the emphasis is constantly placed upon larger aspects of the work and the least importance is placed upon the writing done, the awkward feel of the pencil in the hand, etc.

Transference Effects in Writing. Gates and Taylor (23) published results of a study comparing two groups of kindergarten children in learning to write letters by different methods. Group I was called the *tracing* group, Group II the *copying* group. There were originally approximately seventy children who were divided off into squads of ten and paired to give as near equality as possible in terms of chronological age, mental age, physical age, physical maturity, and motor ability. The children in the *tracing* group were practiced five minutes each day for five days at tracing on tissue paper (through which they could see the letters) large models of the series of letters *a b c d e*. They were then, on the sixth day, given a five-minute test in copying from the model the same letters they had traced; again five days of tracing were given, followed by two days of tests at copying. "After a brief intermission," a test in copying the series *f g h i j* was given them, followed by nine days of tracing practice on this series, and ending with two days of tests at copying (a total of 25 days, of which 19 were devoted to tracing). The children of the *copying* group were given eight days of practice on the *a-e* series and eight on the *f-j* series (a total of 16 days). At the end of the experiment, only twenty-one subjects of the tracing group and fourteen of the copying group remained, due to incomplete records on account of accidents and absences. The

TABLE 6

SCORE UNITS MADE IN SUCCESSIVE FIVE-MINUTE PRACTICES BY THE TRACING GROUP

(21 children)

I. In the first series of practice periods on the letters a-e

Practice periods at tracing →	1	2	3	4	5	– 5-min. test copying *a-e*	6	7	8	9	10	– – Mean of two 5-min. tests at copying *a-e*
Days →	1	2	3	4	5	(6)	7	8	9	10	11	(12, 13)
Mean score	11.4	20.6	20.8	24.2	29.8	**8.2**	35.1	43.4	44.0	48.3	52.4	**11.8**
$P.E._M$	1.8	2.4	2.2	2.7	3.7	**1.1**	3.8	3.9	3.8	3.9	3.9	**1.3**
$V \left(\frac{M.V.}{M}\right)$	.71	.51	.44	.52	.52	**.61**	.50	.42	.41	.37	.34	**.20**

II. In the second series of practice periods on the letters f-j

Practice periods at tracing →	– 5-min. test copying *f-j**	11	12	13	14	15	16	17	18	19	– – Mean of two 5-min. tests at copying *f-j*
Days →	(14)	15	16	17	18	19	20	21	22	23	(24, 25)
Mean score	**.77**	34.8	44.7	55.2	53.8	62.8	63.5	67.3	73.7	76.9	**15.0**
$P.E._M$	**.30**	3.4	4.6	3.8	3.1	3.1	3.4	3.1	3.8	3.5	**1.3**
V	**1.37**	.41	.44	.28	.24	.21	.22	.19	.21	.19	**.43**

*"After a brief intermission"

letters written were scored by an objective system according to the number of strokes required for the writing of each letter (e.g., 4 points for *a,* 3 for *i,* 2 for *c* and *e*).

The results of the practices of the tracing group are shown in Table 6 (with test periods enclosed in vertical bars), and of the copying group in Table 7. The data of both tables are graphically pictured in Figure 5. Unfortunately, we have no means for the copying group on the eighth and the sixteenth days of practice and have had to estimate them in the graphs by dotted circles. (The reader will find it helpful to follow the curves in the immediately following discussion.) Group I (tracing) makes rapid progress through the first five days' practice on the series *a-e,* but their test score at *copying a-e* on the sixth day shows that copying is quite a different process from tracing for these children, who drop from a tracing score of 29.8 (fifth day) to a copying "test" score of 8.2. However, the transfer effect from tracing to copying is evidently measurable by comparing this first copying score (on the sixth day) by Group I with the first copying score (3.7) on the same series *a-e* by Group II. This gives a transfer effect of 122 per cent that Group I got from the five days' practice in tracing. Again Group I makes rapid progress at tracing, from a score of 35.1 (considerably above their preceding tracing score) to one of 52.4. Then on their *a-e copying* tests (twelfth and thirteenth days) they again fall back, from this high point, to an average score for these two days of 11.8. This is a gain on their previous *copying* test score (8.2) of 44 per cent, hardly more than the practice in the tests themselves would afford. But now when Group I takes a *copying* test on the new series *f-j* they fall far back to a score of 0.77. "Some of them were almost completely baffled" (p. 466). This was evidently because the children not

TABLE 7

SCORE UNITS MADE IN SUCCESSIVE FIVE-MINUTE PRACTICES BY THE COPYING GROUP (14 children)

I. In first series of practice periods on the letters a-e

Practice periods → (or days)	1	2	3	4	5	6	7	8
Mean score	3.7	7.2	13.5	17.6	19.5	**21.1**	23.7	-*
$P.E._M$	0.9	1.4	1.3	2.2	2.8	**3.3**	3.3	
V	.89	.70	.34	.43	.42	.44	.41	

II. In second series of practice periods on the letters f-j

Practice periods → (or days)	9	10	11	12	13	14	15	16
Mean score	4.6	15.3	21.4	23.8	24.8	24.5	26.2	–
$P.E._M$	1.0	2.0	2.2	2.0	2.0	2.5	2.7	
V	.61	.40	.31	.21	.21	.25	.26	

*Too few subjects to give a "usable mean."

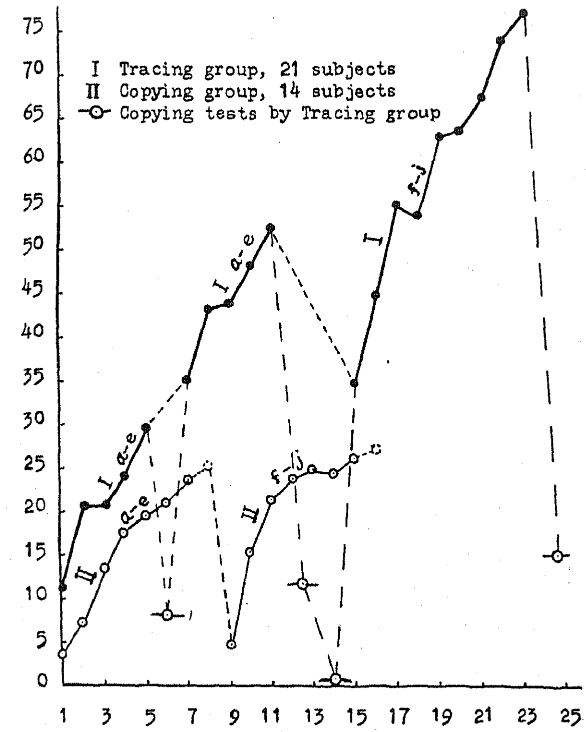

FIGURE 5

MEAN SCORES BY THE TRACING AND THE COPYING GROUPS ON SUCCESSIVE DAYS

only changed kind of work (tracing to copying) but also letter forms. On the fifteenth day, however, on going back to tracing the *f-j* series, they made a score of 34.8, considerably below their highest *a-e* tracing score, and they made very rapid gains throughout their last nine-day practice period. But again the final *f-j* copying test on the twenty-fourth and twenty-fifth days yielded a mean score of only 15.0, showing, however, very much gain over the previous similar copying test score of 0.77. It is safe to say, from studies on adults, that with continued alternating practices beyond this point, and with more equal practice on each sort of process, interferences would have diminished and faded away completely. Group II, which had only copying exercises, also showed considerable interference with the change of letter series. This interference would have vanished relatively early as the slightly different activities in copying and tracing became mastered. At first the attention was so wholly directed to these differences—even the instructions were very different—that the children could hardly respond to the larger similarities in the two letter-writing methods: they could hardly yet "perceive" or react to identical letters by the two processes *as the same.* What could these "letters" mean to

children anyway, or what common impulses could they arouse? The experiment as carried out is hardly comparable in procedure with experiments in transfer on adults by Bergström (4), Culler (16), Brown (12), Schwarz (72), Bray (9), and others, but the last two of these probably indicate why little transfer effect would be expected in this tracing-copying experiment.

As the Gates-Taylor experiment strongly indicated, letter-writing at first is, to the child, largely a particularized process. Each letter or even letter-part has its own individual difficulties. Gradually the whole process attains a unitary aspect as a means of communication or self-expression. Hildreth (34*a*) has tested the number- and letter-copying and writing abilities of 78 kindergarten and first-grade children, classified into four age groups of four years five months, five years five months, six years five months, and six [seven?] years six months (mean IQ's 123, 126, 117, 122, respectively). A form-writing exercise preceded the tests. Unfortunately, detailed statements of the nature of emphasis on successes and of inhibition of errors are lacking. The children copied from samples, series of numbers, letters, and words and were also required to write from dictation the same numbers and letters in differently arranged series. At first younger children would say, "I can't do it," "It's too hard," "I don't know how," etc., and some of the older ones found it "too easy." Three repetitions of the tests at intervals of nine months showed gradual progress from a low to a high degree of success. Writing from memory was especially difficult for the younger children. More detailed and analytic learning experiments, with investigations as to how best to encourage favorable efforts and to eliminate erroneous elements, are needed. The practically universal occurrences in the younger group of lateral number- and letter-inversions suggest the value of experimental studies of early coordinations to spatial and even temporal factors. Ewert (21*e*) has carried out a study on adults whose visual-motor organizations were broken up by the wearing of lenses to invert the image on the retina. The establishment of new associations or organizations was noted, together with effects of audition and other such factors. Ketterlinus (39*c*) has reported a pioneer study of the reactions of young children to mirrored objects. Three problems, roughly graded as to difficulty, were presented to nineteen boys and eight girls (ages two years one month to five years four months): (*a*) picking up objects and putting them into a cup; (*b*) pushing a disc with the foot from one position to another; (*c*) pushing a toy cannon along a path. In every case the objects, limbs, path, etc., were seen only in a mirror. In the second and third problems a pencil attached to the objects themselves made an objective record. Children as young as two years were able to establish habits on the basis of such reversed visual stimuli, but, in general, learning ability increased with age. Large practice effects were noted, but there were too few subjects at each age for the three problems, and also too few trials (two a day for three or four days) for satisfactory results for most purposes. "Mirror

experiments bring out emotional tendencies in children that merit consideration in the guidance of the child."[2]

Relations of Intelligence to Learning-Rate and to Degree of Transference. Woodrow (87) compared normal and feebleminded children of approximately the same mental age on learning to sort wads and on transference effects. He used four groups of children as follows:

	Number of cases	Age in years Mean	M.V.	Mental age Mean	M.V.
Feebleminded practice group (FMP)	20	13.8	1.9	8.1	.8
Feebleminded control group (FMC)	17	13.1	2.8	8.9	.5
Normal practice group (NP)	16	9.1	.5		
Normal control group (NC)	11	9.0	.2		

These four groups were also equalized in initial ability (more accurately than on mental age) on four end-tests—sorting sticks of five lengths into boxes of corresponding lengths, sorting colored pegs, cancellation of letters, and cancellation of forms. These end-tests were given on two different days, both in the initial and the final series. The practice groups were then given thirteen days' practice at sorting gun wads on which were pasted labels (both sides) bearing the printed outlines of one of five simple forms—star, circle, square, cross, and triangle (taken from the Woodworth-Wells blanks). The wads were sorted by the children, under daily instruction to sort *as rapidly as possible,* into five small boxes, each bearing a different one of the labels. Only rights were counted, since the number of errors was negligible. Each child used his preferred hand and picked up only one wad at a time. The small boxes were shifted every second day as to relative positions. Four minutes were devoted to practice each day (separated into two each by a short period in which the small boxes were emptied into the large containers and reshuffled by the children), but only the sortings of the last two minutes were counted.

The results are given in Table 8, and the learning curves of the practice tests in Figure 6. No significant difference appears in rates of learning by the FMP and the NP groups. There is a slight indication of greater transfer effects by the normal children in the letter- and form-cancellation only, but the difference in percentage gain between the normal and the feebleminded groups in this regard is not reliable (mean difference in percentage gain/$P.E._{diff.}$ is 7.6/4.0, or 1.9, for letters; and 5.9/4.2, or 1.4, for forms). As to the higher scores in the second end-tests, certain questions may be raised regarding effects both of practice on the initial tests and practice in the wad-sorting series, since results of the practice and

[2]Clinton (14*a*) has traced the history of the mirror-drawing experiment and has supplied extensive norms by age and sex and the growth in ability from year to year. It would be valuable to have different age groups practice for a few minutes about three times per week through a school year or longer to compare practice results (plus maturity and general exercise effects) with his growth norms and also to compare transfer with maturity effects at different levels.

TABLE 8

WOODROW'S DATA ON LEARNING TO SORT WADS INTO FIVE BOXES ACCORDING TO THEIR FORM-LABELS (STAR, CIRCLE, SQUARE, CROSS, TRIANGLE), AND ON TRANSFER EFFECTS

Group	No.	Mean scores on initial sorting test: Sticks	Pegs	Letters	Forms	Mean scores on practice series in wad-sorting, Successive days: 1	2	3	4	5	6	7	8	9	10	11	12	13	Mean scores on final sorting test: Sticks	Pegs	Letters	Forms
FMP	20	93	102	82	74	121	142	137	149	152	160	155	163	167	168	167	171	175	120	131	111	97
FMC	17																					
NP	16	94	101	81	71	122	136	135	145	153	163	158	163	161	163	163	172	176	124	130	117	98
NC	11																					

the control groups were put together; but certainly in both learning and transfer effects on this sort of material, and for the ranges of IQ here involved, there is little evidence of greater learning-rate by the NP group through thirteen days of practice, or of greater transfer in those children with the higher IQ's. More data on a variety of different sorts of learning material and at different levels of motivation are needed. Possibly with higher MA levels, the experiment by Gates and Taylor would have shown more transference. It is possible also that the more intelligent persons have more drive at continuous work than unintelligent ones [cf. transference, or generalizations, of an eleven-year-old boy, as compared with generalizations of his father from lower to higher levels in a reasoning problem (*infra,* page 475).]

Wilson (86*b*-86*g*) in a series of studies has investigated possible differences in learning between bright and dull children. The experiments include star-tracing; the Witmer cylinder problem of fitting eighteen cylinders of various sizes into their corresponding holes; associating words with various shorthand characters so that they could be reproduced when the characters were again presented; learning to reproduce ideas in meaningful material marked off into idea-units, after selections were read to the children; learning to place the blocks of the Goddard formboard into their proper places when eyes were blindfolded; and learning to play games in which success depends upon the application of some underlying principle. Different groups, usually nine and twelve years of age, varying considerably in IQ's were compared, and the results were studied analytically. Striking similarities in the frequency of learning certain difficult items, on the one hand, and certain easy items, on the other, resulted. The results favor, in general, the view that differences are mostly in *amounts* rather than in *kind*. Further experiments, using a greater variety of activities and wider ranges of difficulties, are desirable before far-reaching generalizations are attempted.

The Learning of Language Symbols in Social Situations

The learning of language in infants and very young children is a subject that has received hardly any attention as an experimental problem. Observational studies have been directed mainly toward the appearance of new words, their sentence relationships, and classifications into parts of speech, etc. It is well known that the babblings and cooings of a child, appearing at a certain rather limited age range, show great spontaneity and that certain easily vocalized lip-sounds like *ma-ma, pa-pa*—which Miller (50) has approximately duplicated by expulsions of air through pipes provided with opening and closing rubber "lips"—occur rather frequently. These responses have no specific import or reference for the child until its social environment has emphasized certain elements and groupings and has shaped them into the more or less definite pronunciations of "words." Peterson (58) has shown how a thirteen-months-old infant,

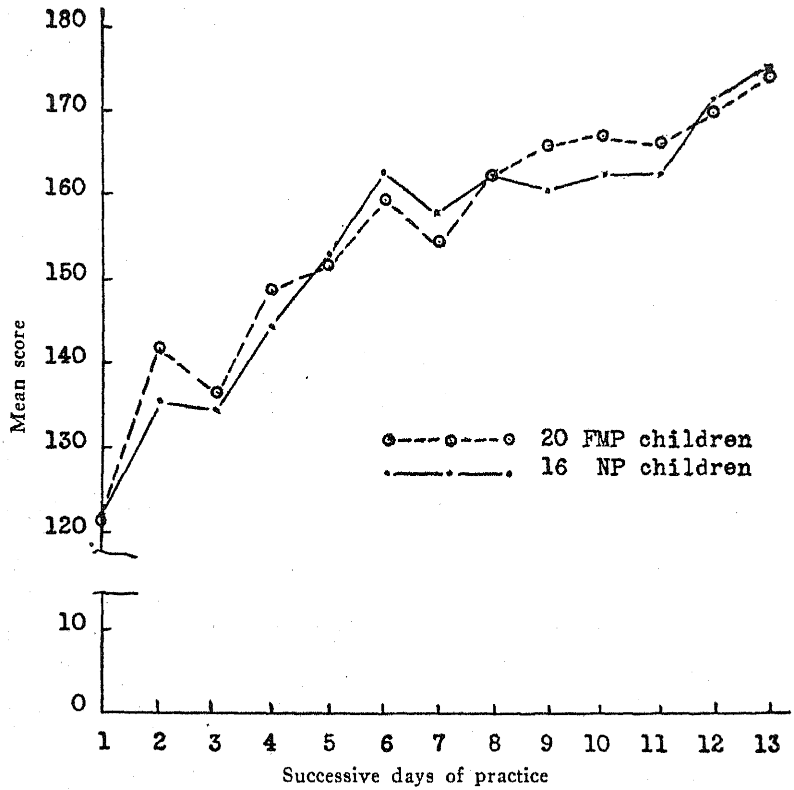

FIGURE 6

MEAN SCORES ON SUCCESSIVE DAYS OF PRACTICE BY THE FMP GROUP AND THE NP GROUP OF CHILDREN

who had acquired certain vocal habits as a foundation, could be interested in (made to respond to) the moon only indirectly through strong, moving and (later) stationary lights; and how he learned to use the word "moon" as a means of social control toward getting responses to himself. Watson (84, pp. 182 ff.) has attempted, by means of pronouncing the stimulus-word and giving rewards for success, to train an infant about six months old, while in the babbling stage, to say "*dada.*" No certain results showing imitation effects in the early stages were obtained, though it is probable that the rewards may have hastened the learning. Other methods of stimulating and emphasizing certain responses are possible.

The most thorough attempt at observations of the language developments in children on an objective basis is probably that of McCarthy (47). Her study was carried out on a total of 140 children, distributed over ages 18, 24, 30, 36, 42, 48, and 54 months, in groups of 10 boys and 10 girls of each age. The children were selected so as to constitute fair

samplings of the different occupational groups in Minneapolis. The author reviews the previous literature in this line of investigation and gives results of her own controlled observations. The interested reader is referred to this monograph, which includes a bibliography of seventy-nine references, and to Chapter 8 of this *Handbook*.

Associative Learning in Children

Effects of Different Distributions and Amounts of Practice. Meek (49) published results of an experiment on word-learning and retention in young children. Six names of common objects—*ball, flag, doll, lion, duck,* and *rose*—were selected to be learned under various distributions of practice. With each of these words, five others similar to it in initial, middle, or final letters were given as "confusing words" from which it was to be discriminated. Those used with *ball,* for instance, were *burr, feel, sale, bake,* and *kill.* The words in every such group of six were severally printed in black primer print on white paper 2 1/2 x 1 inches, and were pasted to the top of gray cardboard boxes 4 1/8 x 2 7/8 x 1 5/8 inches. In every such set of six boxes, a toy was put into the box carrying the word to be taught. Thus in the box with the word *ball* was a ball, in that of another set with *lion* was a toy lion, etc. The other five boxes in each set were empty. The child was told in the case of the first set: "All of these boxes are empty except one. This one has a surprise in it for you. Open it and see what it is." The six boxes were then rearranged according to a chance schedule and the subject was again to "find the word that says *ball.*" The experimenter said "Right" when the right word was pointed out. The process was repeated until the child got the right word a specified number of times, depending on the "type of learning" or the distribution of practice used. This, then, constituted a "practice period." Table 9 shows the different "types of learning" used and the number of recognitions allowed in each practice period. Below is also given the number of days intervening between the successive pairs of practice periods, through a period of thirty days. Thus Type 5Y had 5, 12, 7, 3, 2, and 2 "recog-

TABLE 9
Recognitions at Each Practice Period

Types of learning	Practice period 1	2	3	4	5	6	Total "recognitions" in each type
2X	2	2	2	2	2	2	12
5X	5	2	2	2	2	2	15
8X	8	2	2	2	2	2	18
5Y	5	12	7	3	2	2	31
5Z	5	6	3	2	2	2	20
5W	5		2			2	9
Days since last practice periods		1	2	4	9	14	
Days from first practice		1	3	7	16	30	

nitions" on the six successive practice periods, with 1, 2, 4, 9, and 14 days intervening in the several inter-practice periods, in the order named. The practice periods came on the first, third, seventh, sixteenth, and thirtieth days, respectively.

The subjects were sixty-eight kindergarten children divided into three age groups (16, 37, and 15, respectively) of approximately four, five, and six years. Median IQ's approximated 120. These age groups were again divided into smaller subgroups of approximately six children each and were taught the several six words according to different schedules of distribution ("types of learning") so that (in the five-year-old group) each word was learned by a subgroup in a different way. "The types of learning (see Table 9) were so rotated that, at the end of the experiment, each type of learning had been used by each group for a different word" (p. 5). The four-year-old group was similarly divided into three subgroups, one for each three of the words, and the six-year-olds, likewise divided, were taught two words at each period instead of one. The experimenter thus controlled the age factor, the differences in difficulty of words learned, and the different settings of the several words in the practice series; and she was able thereby to investigate effects of various distributions of initial and of later practice, as well as certain details of the learning, including the cues used, the relation of learning to intelligence, and the effects of different intervals between relearnings.

Results are given in numerous tables and curves in terms of average time in seconds, average number of corrections of errors, and the percentage of children "mis-recognizing" the word in each practice period for the three age groups, both severally and combined (by inadequate weightings, however; see author's page 34). There were evidently too many different groupings and variations in procedure for the number of subjects used, and the reliabilities of results are not adequately considered. The results are best shown in the percentage of children mis-recognizing the words taught,

TABLE 10
EFFECTS OF DIFFERENT INITIAL DISTRIBUTIONS IN WORD LEARNING BY SIXTY-EIGHT KINDERGARTEN CHILDREN

Type of learning	Practice periods 1	2	3	4	5	6
			Average number of seconds			
2X	36.0	31.7	24.8	21.6	27.3	29.9
5X	78.4	17.8	28.6	22.1	25.1	29.0
8X	143.4	26.2	19.1	21.2	17.8	30.3
			Average number of corrections			
2X	2.59	1.95	1.88	1.17	1.49	1.34
5X	3.75	.45	.91	.95	1.17	1.58
8X	5.16	.95	.74	.74	.79	1.56
			Percentage of children mis-recognizing			
2X	63	62	52	59	64	64
5X	84	30	38	54	54	51
8X	81	41	36	38	51	55

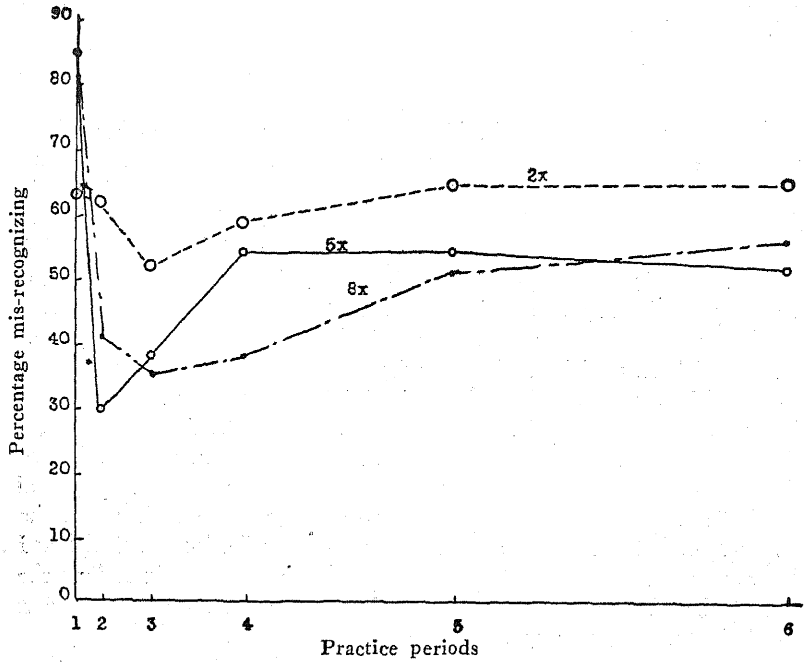

FIGURE 7

PERCENTAGE OF CHILDREN MIS-RECOGNIZING WORDS BEING TAUGHT ACCORDING TO THE DIFFERENT DISTRIBUTIONS OF PRACTICE OR RECOGNITIONS AT EACH PERIOD

The periods were all spaced alike, coming on the first, third, seventh, sixteenth, and thirtieth days.

since this percentage is not affected by extreme cases as are average time and average corrections. The results of differences in initial practice by all groups combined are shown in Table 10 and Figure 7. Generally, there was rapid progress in periods 1 and 2; and, with the different time intervals used between successive pairs of practice periods (1, 2, 4, 9, and 14 days), eight recognitions in the initial period brought less forgetting than five, and five less than two. However, the curves of Types 5X and 8X cross twice. There was a tendency in later periods for the effects of difference in initial practices to disappear. The third to the sixth periods were evidently too far apart for the children. While there is no directly comparable experiment on adults, data available would lead us to expect less forgetting in later periods similarly spaced than shown by these young children.

From her three types of curves, all of which agree, the author summarizes the relative effects of varying amounts of later practice (with initial practice controlled) as follows:

Type of learning	Amount of intervening practice	Relative height of curves at final practice
5W	2 recognitions	highest
5X	8 recognitions	second highest
5Z	13 recognitions	lowest
5Y	24 recognitions	third highest

It is to be noted that high curves represent low efficiency, so that eleven extra practices in Type 5Y over the thirteen practices in Type 5Z "did not contribute to learning but proved a positive hindrance to it" (p. 47). There seem to have been negative effects, both in the initial and in the final trials, of too much concentrated practice on learning and retention. These results need more experimental support, however. Beyond a certain number of recognitions, motivation probably runs down in case of such young children.

A study of cues used in differentiating the words to be learned from the confusing words revealed a considerable (deliberate or accidental) use of certain letters or groups of letters for identification of the former words. The first letters were only slightly, but probably not reliably, more effective as cues than the last, and the middle were least effective. Certain single or double letters like *i, g, ll, o,* and *k* seem, without obvious reasons, to be predominant as cues. The general shape of the word was also a possible factor, but too few data are available for a conclusion. The cue selected was in general a function of "the total situation which is set up" (i.e., general relationships of the several words presented). A careful tabulation of learning ability of the five-year-olds at two-week intervals revealed no increase in such ability as was involved in the experiment within the thirty-day period of the experiment, but this result cannot be considered final in view of other variables and the small number of cases involved in the experiment. A slight but unreliable positive relationship of learning-rate to mental age was found in each age group.

Miscellaneous Problems in the Learning of Associations by Children. In 1926, Kirkwood (41) carried out an experiment in association learning on 180 children, ranging in age from one and a half to six and a half years. "There were too few subjects at the lower ages for statistical analysis" (p. 20), but "the majority" of the children in this study came within the age limits of five and five and a half years. Unfortunately, no more definite statement of ages occurs, and the numbers in each experimental group are given without any further statement of ages. Sex was not taken note of in the experimental groupings, but in the total number of cases the sexes were apparently about equal. The experiment began with 203 children, but the results of 23 were discarded either because of absence or of "failure to learn completely the material by the end of the twentieth trial" (p. 19). The materials used were a series of twenty blocks of different forms (circle, square, triangle, cross, pentagon, etc.) and one of twenty simple outline pictures drawn in India ink on unruled

cards, 3 x 5 inches, "to represent objects that are in some way similar to the blocks." With only one exception, these pictures were of objects familiar to the children (clock-face, kite, duck, bell, train, house, leaf, etc.). The twenty blocks were so devised "that the complete series may be regarded as consisting of two parallel series arranged in approximate order of complexity," Blocks 11 to 20 of Series II being modifications of the corresponding numbers 1 to 10 in Series I. These materials were presented to the different groups of children according to three different schedules either on successive or on alternate days, "to investigate some of the important problems involved in the study of the learning process" (p. 9).

Three different forms of presentation of materials were used—the "standard form" (to 132 children, p. 20), the "standard form interchanged" (to 15 children), and the "single series form" (to 48 children) —the materials in all cases being presented to the children individually according to a predetermined schedule. Simple instructions were given while handling and pointing to the blocks. The experimenter would say: "When I show you *this* picture, you must give me *this* block," picking up and showing Block 1 from the arbitrary position it occupies in the "form of presentation" used. Thus, on the standard form, the whole series of twenty blocks (ten in the "single series") is gone through, each block being replaced in its correct position before the next picture is shown. Then the examiner, holding up the first picture, says: "Now it's your turn. Give me the block that goes with this picture." The whole series is thus repeated, the instructions being gradually abbreviated and omitted when unnecessary. Certain children were given trials (apparently one each day, though this is not clearly stated) "on successive days" (120 subjects on the standard form, 15 on the standard form interchanged, and 24 on the single series), and others (12 on the standard form and 24 on the single series) on alternate days. It would certainly be important to ascertain effects of different arrangements of more concentrated distributions of trials in the early part of the practice, but such a program will require several extensive researches with the use of different kinds of material.

In the "standard form interchanged" new associations of pictures and blocks were to be made, appropriate instructions being given as in the case of the standard form; and in the "single series" only Series I or Series II was presented to every child of the group involved, to determine by comparisons whether the learning of Series I had any effect in the longer series upon the learning of Series II and also to compare the two comparable short series as to differences in difficulty and priority of presentation. Each right choice in any series was counted as one score, so that the total score possible in any long series or day was 20.

The standard adopted for the complete learning of a series was three consecutive perfect scores. When this stage was attained in any of the three forms of presentation, a check on the learning was given. This con-

sisted of an additional trial with conditions so reversed that now the *pictures* were before the child and the *blocks* were presented to him with the request for each block that its corresponding picture be pointed out. Moreover, since some of the children who had taken the "standard form" of presentation were available a year later, they were again taken through the same form that they had at first completed, to determine the degree of retention. Only thirteen children thus relearned their series, six by the successive- and seven by the alternate-day practice. In all these experiments complete records were kept (including comments by the children as to perceived similarities) to determine why certain associations were more readily made than others, etc.

The statements of results are too complicated for detailed consideration. Moreover, they omit too many relevant details, such as reliability of pairings of certain of the children according to given tests, the extent of previous practice of the several children in learning, and the "form of presentation" followed in the previous practice (some of the subjects apparently learned more than one form), etc. Many of these details were probably taken care of, but they are not clear to the reader, even after rereadings.

Effects of Distributed Practice. A special comparative study as to effects of distribution of practice (successive or alternate days) was made of the results of twenty-two children on the standard form, paired roughly as to equality in MA (Stanford-Binet), on height and weight, and (partly) on sex. There is apparently (from calculations by the writer based on the individual scores in the author's Table 5) a reliable difference in the number of trials required, favoring the eleven subjects who practiced on successive days. The results are given in Table 11 and are shown graphically in Figure 8. Greater economy in learning is associated with wider distribution of practice. This agrees with results usually found on adult humans and also on animals, and reveals nothing peculiar to the learning in children in this respect.

Ligon (43*b*) has reported data on a genetic study of color-naming and reading of color names by over six hundred children. The study can only be cited here together with studies of the same processes by Peterson and Walker (67), Telford (78*a*), and Lund (45*a*). An important problem in child learning is involved and more data from tests affording constant motivation are needed.

TABLE 11

MEAN NUMBER OF CORRECT SCORES BY TWENTY-TWO PAIRED CHILDREN IN THE STANDARD FORM OF PRESENTATION OF BLOCKS FOR ASSOCIATION WITH PICTURES

Number of children	Practice periods 1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Distribution of practice—successive days													
11	10.2	14.9	16.5	18.8	19.1	19.0	19.8	19.6	19.3	20.0	19.7	20.0	20.0	20.0
	Distribution of practice—alternate days													
11	11.3	15.2	18.9	19.6	20.0	19.8	20.0	20.0	20.0					

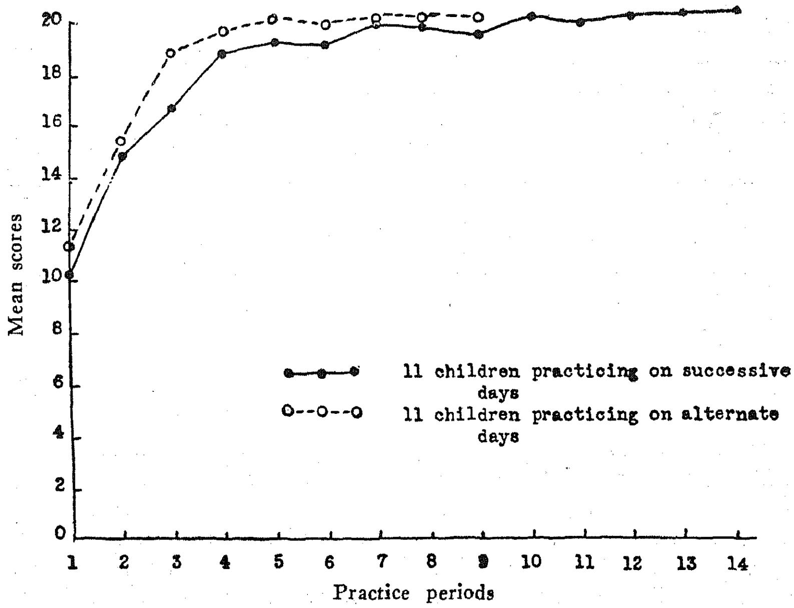

FIGURE 8

Mean Number of Correct Scores in the Standard Form of Presentation of Blocks for Association with Pictures by the Children Practicing on Successive Days with Those Practicing on Alternate Days

Motivation Factors in Learning

Probably the most important condition for learning is motivation. In general, by "motivation" psychologists mean stimulation to some particular line of activity that is being investigated (whether or not the subject is purposely trying to reach a particular end). If we are studying the learning of animals to avoid certain obstructions in the way of getting to food in some problem box, or of children to walk, spell, or throw darts, we are concerned only with the arousing and controlling stimuli, not with irrelevant ones. Theoretically, there may not be any irrelevant stimuli. If we study *degree of any sort of activity,* all stimuli affecting the organism are relevant. The subject may—particularly in cases involving proprioceptive and interoceptive mechanisms—be wholly unaware of the stimuli affecting him, e.g., a decerebrated pigeon driven about by interoceptive (gastric) stimuli, or a cross and irritable child stimulated by fatigue poisons. Investigators of animal behavior have contributed valuable data on learning in relation to age, and indirectly to motivation (cf. Watson, 83; Yerkes, 88, pp. 270-277; Hubbert, 35; Liu, 44; and Stone, 76, 77). Stone's work, in particular, is of prime importance to investigators of child learning, and to educators generally. Despite the considerable data showing more rapid learning by young than by older animals, Stone has shown by the use of different degrees of deprivation

of food that, with *equal hunger motivation,* young do not excel old animals in learning of several different kinds. Equal (objectively measured) feeding imposes greater hunger drives on the younger animals because they are growing in size as well as spending energy in the learning and other exercises; feeding just enough to maintain constant bodily weight means starving the growing animals so that they cannot grow normally. Growth norms, as these studies indicate, are necessary so that young animals, compared in learning-rate with adult animals, may be kept to the normal size for their ages while the adults' weight is held constant. Other factors must also be considered, such as fatiguability, degree of hardening to practice, previous specific practice, etc. When equally motivated at different age levels, young rats show no superiority to old ones up to the age of senescence, and they come to their learning maturity at thirty to seventy-five days of age (corresponding probably to puberty in humans).

Experiments on Comparative Methods of Motivation. Motivation experiments by Chase (13*a*), carried out on 213 children who varied in ages from twenty-seven to ninety-six months, indicate possible reversals of what Thorndike (79*a,* Chap. 11) found on adults, in the effectiveness of motives in children. Chase found it "highly probable" that failure-repetition, failure-reproof, and failure-punishment are more effective connections for performances than are success-repetition, success-praise, and success-reward. Similar results, giving punishment relatively greater effectiveness than reward, have been obtained on animals by Hoge and Stocking (34*c*), Dodson (21*a*), and Warden and Aylesworth (81*a*). But whether young children resemble animals in this regard more than they do adult man is a question still beclouded by many differences in the techniques of experimentation on these three types of subjects and by differences in their earlier living and learning. We must in time differentiate carefully among varieties of animals, personalities of children and adult human beings, and varieties of problems and rewards and punishments.

Difficulties in the Control of Motivation in Children. Motivation on a learning problem is difficult to control in children. They fatigue early, have no strong persevering sets, are easily distracted, subject to many illnesses and diseases, and hence to irregularity in attendance; they rebel at continuing to practice on mere symbolic forms, are easily disturbed emotionally, etc. (cf. *supra* pages 431, 432, 433, 434, 435, 437, 447, 448); whereas adults, though often well-trained and good subjects, are, as a rule, so set in professional, economic, and social affairs, and unequally trained, as to be differentially susceptible to experimental conditions at different ages up to senility. While the numerous data presented by Thorndike (80) and his collaborators, gathered from various sources and including some definite experimentation, indicate in human subjects a general increase with negative acceleration in "ability to learn" up to about twenty-six to twenty-eight years (p. 127) and thereafter a general decline, one must not, as Thorndike is careful to indicate, over-

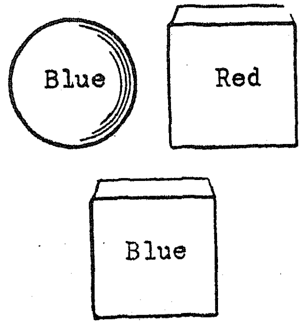

FIGURE 9

ILLUSTRATING PLACEMENT OF FORMS BEFORE THE CHILD

(Modified from C. R. Brian and F. L. Goodenough's "The Relative Potency of Color and Form Perception at Various Ages." *J. Exper. Psychol.*, 1929, **12**, 199.)

look the inadequacy of such comparisons of learning at different ages until numerous factors, like those already suggested, are controlled.

Some External Factors in Motivation. Brian and Goodenough (11) had 474 subjects, varying in age from two years to maturity, choose from two objects differing both in form and color the one "that is just like" a third put near them which resembled the one in color and the other in form (e.g., choice from a *blue ball* and a *red cube* to be like a *blue cube,* Figure 9). They found, in general agreement with results of Descoeudres (21), that children below three years chose on the basis of form; that from about three to six years the color basis predominated; and that above this period the choices were again based mainly on form. These experiments indicate dominant motivation by different elements or aspects of objects at different levels of development, and they suggest, in general, methods by which other motivation factors may be compared as to relative efficiency at different periods of development.

Roberts (71*d*) investigated the ability of children to respond to a simple constant relationship (color agreement) between a toy airplane and the means of obtaining it (opening one of three doors of different colors). The subjects were forty-three children with IQ's of 91 to 151, grouped in age levels of two, three, four, and five years. No language responses were required and motivation was satisfactory; moreover, everything necessary for solving the problem was visible. While all the children were able to learn to solve the problem, even though different colors were successively used as the "significant" color, not all of them discovered the principle of color agreement. For all age levels but the lowest there was a reduction in number of trials required for solution from one series of trials with a given color used to the next series with a different color. The control of space and other factors does not seem to have been sufficient to force all children to solve the problems strictly on the color relationships intended.

Relative Judgments in Learning. Köhler's experiment with a three-year-old child (Koffka, 41*b*), showing that it could learn to choose, for a candy lure, always the brighter of various pairs of boxes placed before it, has stimulated a recent experiment under carefully controlled conditions by Jones and Dunn (39*b*). Using four different variables—area, form, brightness, and hue—each in four degrees, 1, 2, 3, and 4, and training on the intermediate degrees 2 and 3, they tested for relative judgments on the extreme degrees 1 and 2 or 3 and 4 in the case of each variable. Eighty children (mean age 68.2 ± 2.5 months) showed great individual differences in proportion of "relative" to "absolute" judgments, the whole group (and 62 of them in a second test) making a proportion of relative judgments appreciably above chance expectations. The investigators found no relation between proportion of relative choices and age or MA in the group of children used. The reliability of the two tests was only .52.

On a problem quite similar, employing slightly different technique, in which the child motivates himself in a degree by the sound of a bell which rings only when he presses on the "positive" object, Rüssel (71*e*) has established the transposability of relative judgments on such contrasting qualities as contoured-flat, thick-thin, large-small, round-pointed, symmetrical-asymmetrical. In ordinary psychological terminology, the relative judgments obtained by any method could be described as aspects of "transfer of training" in attitude or "set." There is nothing extraordinary about the conception, but the method of relative judgments is a useful one in learning, particularly by humans. Hicks and Stewart (33*b*), in an experiment on forty children (ten each of ages two, three, four, and five years), found that thirty-one children were able to learn to select the middle-sized blocks in different choices from three blocks presented each time even though absolute size and position in the trio were varied in a chance order. They used, in all, six blocks (4, 6, 8, 10, 12, and 14 sq. cm., respectively) in four different series so arranged that the extremes of any set of three blocks differed in edge length by only 4 cm. The criterion for learning was fifteen correct choices in succession. The training was confined to only one series, and reactions were then obtained to other series of different sizes. Errors and trials were found to decrease with advancing age levels. There seems to be no good reason for calling such choice of middleness the "learning of abstract concepts of size."

Spatial and Temporal Factors in Adjustment to Environment

A line of experiments on learning in children which promises to give important results both for this particular field and for experimental psychology, generally, has followed the suggestion by Peterson (64*a*) that "local signs" are really orientation tendencies and that therefore "local signature and perception, both spatial and temporal, become only special aspects of the general field of learning. . . . Young animals and infants may be used as subjects and investigations can be made to determine how readily and in what manner responses to various local stimuli become or-

ganized" (p. 236). Dunford (21*b*), using ten children for each of the age levels three, five, seven, nine, eleven, and fifteen years, gave each child practice to the extent of fifty localizations on alternate days for five such days. All age groups showed consistent improvement in accuracy throughout the period. It is unfortunate that the limit of such improvement was not explored. There was no significant relationship between the size and the direction of errors of localization, even though the younger children erred more in the proximal and the older ones in the distal direction. Great skill was found even in the three-year-olds. Results supported the view that "local signature is but a special aspect of the general problem of learning."

Renshaw (71*a*), under whose direction Dunford's work was probably done, published the same year results in agreement with his. Renshaw used seven adults and four children, ages about ten years, as subjects. The children showed markedly greater accuracy in localization than did the adults, even when allowance was made for the children's smaller hands. In these experiments the subjects were blindfolded and, with the free hand, indicated with a wooden pencil, on cessation of the stimulus, the point stimulated. (They were instructed to put the point of the pencil down immediately and not to move it afterwards to "hunt" for the point stimulated.) This is the tactual-kinaesthetic (T-K) method. Further results were secured on two adults and two twelve-year-old boys; in this part of the experiment both the T-K and a purely verbal method were used for localization of the stimulated area. The boys excelled in the first and the men in the second procedure. Renshaw proposed the hypothesis that tactual-kinaesthetic guidance in localization in children becomes replaced by visual guidance in adults. His second article (71*c*), with Wherry and Newlin, reported experiments to test this hypothesis. In these experiments the localization ability for touch stimuli of blind was compared with that of seeing subjects in both adults and children. Results showed that the seeing children were superior to both blind and seeing adults, but that blind adults were superior to seeing adults and to blind children. This was taken to confirm the hypothesis. The data indicated also that the change to visual guidance occurred near the age of puberty. The third article by Renshaw and Wherry (71*b*), appearing the following year, was carried out on fifty-five male subjects, five for each year-age six, seven, eight, etc., to sixteen, inclusive. Each subject was required to make fifty localizations by the T-K and fifty by the verbal method. The data showed the T-K localizations to be superior in accuracy to the verbal for children from eight through twelve years, but these relations were reversed after the thirteenth year of age, even though at this age there was marked increase in accuracy by both methods.

Knotts and Miles (41*a*) have found the stylus maze, and especially the high-relief maze, "admirably" adapted for use with blind subjects, and they have presented both means and medians, with variability measures, on twenty seeing and twenty blind children on each kind of maze, as well

as both error and time learning curves which show progress through ten trials for the two pairs of comparable groups. The average measures represent trials, time, and error scores both for the individuals and for all children of each group. The Warden T-maze of ten culs-de-sac in identical patterns was used. The high-relief maze was the easier for both blind and seeing subjects. The stylus maze was easier for the blind than for the seeing children, but no such difference occurred in the case of the relief maze. The curves are of the same character for both groups. Correlations of maze learning efficiency with MA were greater—some cases as high as .75—than with age. Verbal aids were used more extensively by the blind than by the seeing children.

Coordinations to Temporal Stimuli. Eigler (21*c*), using a stimulus-key apparatus that flashed intermittently a red light at the rate of one flash of 2/3 second's duration each 2 seconds, had her subjects (53 children, ages 20 to 71 months, and, for comparisons, 30 adults) attempt to press a key to ring a bell synchronously with the light-flash. The bell would not ring if the key were pressed while the light was out (in parts of the experiment the child would receive a slight 2300-volts 0.2-milliampere electric shock if the key were pressed while the light was not on). Objective kymographic records were made of both the stimulus and the response series; and progress toward accurately synchronized responses was studied. All the children as well as adults showed the development of true learning patterns characterized by the usual individual differences. Results showed that (except for twelve children for whom the shock was very disturbing) learning was increased in rate and regularity by the shock. The order of error elimination was: omissions and asynchronizations, anticipations, lags. Adults and older children made fewer initial errors and learned more rapidly. This is a suggestive technique for analysis of learning patterns at all stages under the effects of various motivating stimuli.

Experiments on Retention. Sets and attitudes are clearly reactions to the temporal aspects of environment. They are doubtless early aspects of reactions to remote stimuli, and are closely related to spatial factors in behavior. Hetzer and Wislitzky (31*a*) have studied early phases of expectation and memory in infants. A red porcelain bell with a mild sound was shown to ten infants two to six months old, at intervals of 10 seconds. The reactions to the disappearance of the bell manifested three stages: fixation of the spot where the bell had just disappeared, characteristic of infants two months old; search for the bell, rather common to infants three and four months of age; and watching for its reappearance (i.e., expectation). While no child manifested expectation after the first disappearance, 80 per cent of the five-month and 100 per cent of the six-month infants showed such anticipations after the sixth disappearance. For memory experiments these investigators used a blue rubber ball (6 cm. in diameter) so constructed that when squeezed it emitted through an invagination a little yellow chick. Each child was allowed to play with

this ball one minute. Later a similar ball without the chick was given the child and reactions were noted. Some young infants were afraid of the ball with the chick so a hollow five-sided cube of 6-cm. edge with a toy rattle, etc., inside was also used. For the ball-and-chick experiment ten children were used for each month-age from twelve to twenty-three months, while for the cube twenty-five for each such age from nine to twenty-three months were used. Memory was judged by the child's being puzzled when the chick (or the cube-rattle stimulus) was absent and by a quieted or satisfied appearance when the ball with the chick (or the box with its contents) was restored. Delay periods with memory still persisting were tentatively established on other children to avoid practice effects on the experimental groups. For the age groups 12-14, 15-17, 18-20, and 21-23 months, that delay for which approximately 80 per cent of the children in the age group in question gave evidence of memory (according to the criterion chosen) was 3, 5, 11, and 17 minutes, respectively.

Burtt (12*a*), by the relearning method, has demonstrated on a boy of IQ 130 the appreciable retention of nonsense material from infancy to the age of eight and one-half years. Meaningless material (20-line selections from Sophocles' *Oedipus Tyrannus* in the original Greek) was read aloud to the subject daily, beginning when he was fifteen months old. A new 20-line selection was used each succeeding fifteen months, until seven such selections had been read. When the child was eight and one-half years old he learned all the original material by a modified prompting method and also three other similar selections *de novo*. The child was not informed as to which selections were new and a procedure to equate practice effects was used. The mean number of repetitions necessary for the first complete recitation of the new material was 435, for the old it was 317, a saving over the new of 27 per cent.

Emerson (21*d*) has investigated the effects of bodily orientation on the child's memory of the position of objects. The performance was the placing of rings in nine positions on an easel to match those placed on another easel by the experimenter (reliability, by method of scores of odd- and even-numbered children, was .88). Emerson found on thirty-two children of ages two to five years that changes in the position of the child's easel which required shifts in bodily orientation made the child less accurate in placing the rings. The experiment is suggestive to investigators of time-space orientations.

Delayed Reactions. Hunter (37, 38) found that the maximum delays of responses possible to certain animals and children, after preliminary associations of "reward" with a light in a tripartite division of compartments, were as follows: rats, 10 seconds (possible only with gross bodily orientation—rats keeping body and head toward position of light when it was turned off); dogs, 5 seconds (head orientation required); and raccoons, 25 seconds (without visible orientation) (the means of maintaining the effects of the stimulus by the raccoons until these animals were released is not yet known); for a child, T, of thirteen to sixteen months, with

undeveloped vocal and gesture language ("direct" method with no previous association, but simply distracted for a time after holding a play-object and seeing it placed in one of three boxes, and then being allowed to reach for it or show other correct responses to it), 20 to 25 seconds; two-and-a-half-year-old child, 50 seconds; two six-year-old boys and one eight-year-old girl, somewhat over 20 minutes; one six-year-old girl, 25 minutes. All the children over two years of age made preliminary associations with a light (pushing the "noisy" electric button) and were distracted by stories, by making drawings, etc., during the delay. Language habits may be important aids in maintaining such delays followed by successful reactions, if the child has developed such habits. T had *some* vocal and gesture acquirements.

Gellermann (23*b*) has tested thirty-eight children of ages three to thirteen years and twenty-five adults on the Hunter double-alternation temporal-maze problem, which grew out of work on single-alternation experiments in which animals had to follow a right and left alternation response scheme, *rlrl*. The double-alternation problem requires two successive similar responses, *rrll*, and is much harder. The temporal maze here used is so arranged that the human or animal tested may go either by a right or by a left pathway to the back of the maze and then, irrespective of the first choice, come forward by a return path in the middle of the maze so that the two routes have a common finishing pathway. It is readily seen that the double-alternation problem assumes the aspect of a delayed-reaction problem. Gellermann (23*a*), Hunter (38*a*), and others had found that the order of superiority of certain animals in this problem was chimpanzee, monkey, raccoon, and white rat. In the present experiment, involving human subjects, the motivation was different (being told to keep moving, instead of receiving food or electric shock), but subjects were kept ignorant of the problem and were given no other verbal instructions. Thirty-six of the children (mean age 9.4±1.56 years) learned the problem in an average of 15.4±5.06 trials (range 4-37 trials), while the 25 adults (college students with mean age of 20.6±.87) required 6.2±2.53 trials (range 1-16 trials). The human subjects all learned the problem much more quickly than the monkeys had done, and in a single practice period. They formulated their problems in verbal terms. It is still a question how the animals retain the hold-over effects to solve the problem.

Tinklepaugh (80*a*) has applied a series of multiple delayed-reaction tests to two chimpanzees, two monkeys, and, in an incidental manner, to several human children and adults. In every situation there was a pair of containers into the right or left of which food had been placed as observed by the subject. In some experiments the containers were arranged one pair in each of a number of rooms; in others the pairs were arranged in a circle in a single room with the subject in the center of the circle. After a given period of delay the subject was permitted to obtain the lure (food or what not) from the container into which he had seen it put, either in the order in which it was placed, or in a broken or reverse order.

With a single pair of containers in each of ten rooms the two chimpanzees chose with an accuracy of 88 and 92 per cent. With a pair of containers in each of five rooms the two monkeys chose with an accuracy of 78 and 80 per cent right choices. When the containers were arranged in a circle in one room with different numbers of container pairs the results were as follows:

Pairs		3	4	6	8	12	16
Percentage of right choices	Monkeys	73,77	64,84	50,78	56,66		
	Chimpanzees				85,90	81,79	78,89

The monkeys were considerably inferior, though motivation was judged to be about equal. The conclusion that the experiment measures "native memory capacity," because there was no improvement in practice, is of doubtful validity. The chimpanzees equaled the human adults on the initial 16-pair test, and children from seven to nine years were inferior to them. Chimpanzees responded correctly to three pairs of containers after a delay of one week. To all the subjects place cues were important. Studies of this kind raise questions as to the manner of retention of cues, and show, on close analysis, that these questions are not solved even for humans. Verbalization, orientation tendencies, etc., are of course only incomplete suggestions.

Repeating a series of digits (in measurement of "memory span"), after the entire series has been read to the subject, is another form of delayed response, the span regularly increasing with age and advancement up to college level (Humpstone, 36). Martin and Fernberger (46) found on two "highly intelligent" college men that the auditory-vocal span was considerably increased (47 and 36 per cent with 52 and 57 short daily practices, respectively) by means of groupings of the items. Gates (22), on eighty-two children, divided into control and practice groups and equated for age, intelligence, etc., also found an increase of the digit span with training derived from seventy-eight short practices extending over a period of five months. But the entire (statistically reliable) gain of the practice group over the control group was lost in four and a half months when another test was given. The helpful habits acquired for this particular response were evidently of a special and evanescent nature. Constant use of such habits in daily life would doubtless keep them in good working efficiency, and make possible the building upon them of hierarchical systems of "ideas" and more or less detachable and generalized habit systems capable of functioning in various similar activities. The general operation of such systems under different sorts and degrees of motivation needs careful study by as quantitative methods as possible.

Hicks and Carr (34) compared the learning of a maze by four graduate men, five children (ages eight to thirteen years), and twenty-three rats, to find whether the obviously different levels of intelligence were

reflected in specific differences in learning by the three groups. The human subjects actually went through the runways on an out-of-door human maze judged to be comparable in difficulty to the rat mazes for the rats, the difference, if any, probably favoring the adult humans a little. It was found that the rats and the children excelled the men in percentage rate of elimination of surplus time, errors, and excess distance run in successive trials, but that the difference was due to greater caution of the men in early trials. The rats and children showed similarities in piling up a greater number of initial errors (and therefore excess distance) which, when corrected later, would correspondingly increase the percentage of elimination of such scores.[3] The animals and children were also relatively more speedy and heedless at first. Gould and Perrin (27) found in stylus-maze learning a similar tendency to greater caution in fourteen adults than in ten children of a mean age of approximately 11.6 years. These children were, however, of a superior selection and possessed a degree of maturity that tended to minimize the difference in the groups. Though the adults had fewer errors, trials, and shorter excess distance, and took less time absolutely, on the average, they made relatively (in terms of percentage distribution curves) poorer records in the first two trials where chance factors weighed heavily; but their elimination of errors and excess distance was more rapid and regular.

This increasingly cautious behavior in humans, with advance in years and experience, is indicative of sets and hold-over effects from past experience, and it is probably also in a measure due to greater maturity in cerebral inhibitory mechanisms. How these mechanisms (whether acquired or innate) operate is yet an unsolved problem in many respects. The general fact of hold-over tendencies from past stimulus-response activity is, however, now an established fact. To say that such behavior is due to images or ideas is not a very acceptable explanation. It is obvious, even in animal behavior and that of early infancy in humans, that repeated experience with maze and other problem-situations develops (gradually in animals and very young infants, more rapidly in man) an increasing tendency to react to the situation as a whole, so that inconsistent details in the responses become eliminated, and the subject reacts to the situation as if certain essential features were anticipated. Such behavior is described as revealing "insight," but this is, of course, not an explanatory term.

We are now ready to consider more in detail experiments requiring, for the solution of the problems set, behavior of this more largely integrated type.

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[3]Peterson (56) has shown that, in general, the greater the initial height of time, error, and distance curves in learning, when plotted on an absolute scale, the more rapid the decline of the curves in subsequent trials.

Multiple-Choice and Rational Learning

Higher Forms of Learning. It is generally agreed, among objective psychologists, at any rate, that thinking and reasoning are not essentially different from the adaptive processes now so familiar to us in ordinary trial-and-error learning [see, e.g., Watson (84, rev. ed., Chaps. 10 and 11); Dashiell (19, Chap. 17)]. Peterson (64) has shown that both in children and in adults the commonly assumed boundaries between the acquirement of skill in voluntarily controlled acts and trial-and-error learning are questionable. It is probable that ideational behavior grades off gradually into the lower forms of delayed responses which are due merely either to conflicts in immediate impulses or to momentary checking of activity by some external situation.

Hamilton's Multiple-Choice Learning. Hamilton (28, 29) has devised a problem of such a nature that an animal or a human being, in getting out of a small compartment to food or to some other objective, had each time to choose among four different doors on one side of the compartment. The conditions were so controlled by the experimenter that only one door was left unlocked each time. Which one could be opened, the subject had no way of anticipating, but the door through which the subject had escaped the immediately preceding time could never be opened (i.e., no door was left unlocked twice in succession); so the choice, when once this fact had been learned, would be limited to one of the three other doors through which escape might be possible. Which of the three doors would be unlocked each time was predetermined by the experimenter according to a chance-order schedule known only to him. The experimenter noted carefully the methods of escape each time and other details of individual behavior. Subjects were human beings of different ages (some defective), monkeys, dogs, cats, a horse, etc. Five reaction types—A, B, C, D, and E—were roughly distinguished. In Type A, the subject, after preliminary learning, omitted each trial the last door opened and tried the other doors according to some plan. In Type B, the subject tried all four doors only one time each, but in an irregular order. In Type C, the four doors were tried in a definite order, either from left to right or the reverse. In Type D, the subject's responses were different from those in Type C in that one or more doors might be tried more than once, but never in immediate succession. In Type E, perseverative reactions were manifested, the subject trying any door two or more times in succession without an intermediate trial on others. Hamilton found that learning under Type A was displayed only by normal adult human subjects, that monkeys, dogs, cats, horses, and children gave Type B responses; that Type C was especially manifested by monkeys, whereas Types D and E represented the learning responses of considerably lower animal forms and of abnormal human individuals. Hamilton (30) has more recently applied his conceptions to abnormal psychology.

Yerkes' Experiments in Multiple-Choice Learning. Yerkes (89, 90) devised an apparatus for a unique type of multiple-choice learning. Various animals (crows, pigs, porcupines, monkeys, etc.) have been taken through long experiments, and a special apparatus has been made for humans. A problem box before the child presents eleven keys which are so easily shoved back, as required by a prearranged schedule for testing, that the experimenter can present any number of keys desired to the subject in various spatial locations on the keyboard. Yerkes has certain standard types of problem. In Problem 1, success always attends the trying of the first key on the left whether there are 2, 3, 4, to 12 keys. The subject is given no help and is left to learn, wholly by his own efforts, the principle on which success will be attained. In Problems 2, 3, and 4, the subject must learn to choose always the second key on the right, alternately the first at the left and the first on the right, and the middle one, respectively, of those available.[4] These problems are arranged in a sort of ascending series as to difficulty, and, through rather laborious experimentation, the subject's rating is obtained. Any problem may, of course, be presented alone. Not only is the subject's extent of progress up the scale noted, but records are made of the kind of errors as well as of other characteristic behavior shown.

Rational Learning: Age and Race Norms for Children. Out of this background, particularly stimulated by the experiments of Hamilton and Yerkes, Peterson (59) developed what he has called the Rational Learning Problem, which is strictly for humans. Different forms are used for subjects of different ages. As used first for adults, the letters *A, B, C, D, E, F, G, H, I,* and *J* are numbered in a random order from 1 to 10. The number of each letter remains the same throughout, and the subject has to learn this number so that he can go right through the series twice in succession without an error. When the subject has carefully read the instructions, the experimenter calls out "*A*," and the subject guesses until he gets the correct number. Then the experimenter says, "Right," and calls out "*B*"; and so on through the series. When the right number for each letter has been obtained the process is repeated again through the series from *A* to *J*. This procedure goes on until there are two successive trials with no errors at all.

It is obvious that if *A* is found to be 9 the subject would not be right in guessing 9 for *B* or for any subsequent letter; that, if the situation is kept well in mind, the subject may organize his thinking so well that chance

[4]In the 1921 article these problems are modified: Problem 3 in the text above becomes Problem 2, and Problem 3 is the choice of the third key from the left. Several other problems are suggested. Yerkes gives results from various humans, both normal and abnormal, and also picture-illustrations of the stages of development of the apparatus. The value of Yerkes' work on the multiple-choice method has not yet been fully brought out by experimentation on large numbers of children at different ages and degrees of mentality or of mental deterioration. An adequate standardization of learning for different ages through childhood and youth would be an enormous undertaking.

gradually gives way to certainty with progress through the series; and that he may know what *J* is (when he comes to it) without any element of guessing. Errors are of three types: *unclassified,* including all wrong choices; *logical*, including choices of numbers that have been found correct for previous letters in the series; and *perseverative,* choices of the same (wrong) number more than once while determining the number of any one letter. All of the subject's reactions are recorded by the experimenter under the several letters for which they were chosen or guessed; and the time elapsing from the calling-out of the first letter by the experimenter to the giving of the last response of the second successive errorless series by the subject is recorded. The score is in terms of the number of minutes, of errors, and of repetitions (including the last two errorless repetitions). Total errors include logical and perseverative errors and exceed the unclassified errors, because any error may come under all three classes and be counted three times, or under two classes only, and be counted twice. The record of a sophomore college student in terms of errors, time, and number of repetitions when completed and scored is shown in Table 12. Figure 10 shows learning curves of the mean number of errors made on successive trials by nineteen subjects.

This learning problem has been simplified for children of different ages by the use of five or seven letters only and has been extensively applied to white and Negro children (Peterson, 62; Peterson, Lanier, and Walker, 67; Peterson and Lanier, 66; and Peterson and Telford, 68) in comparisons as to learning (see Table 13). The Rational Learning Problem requires for efficient solution the holding in mind of a relatively complex situation involving immediately past responses, while the subject organizes the various elements so as to reduce errors as rapidly as possible. It is obvious that if the subject forgets numbers that have been correctly guessed he is likely to call these already used numbers for other letters and thus increase the chance element in the solution of the other letters. The complexity of the problem may be varied considerably by an increase or decrease of letters, without essentially changing its nature.

The problem since 1923 is preceded by a fore-exercise problem of three letters. The experimenter says to the child:

> "The letters *A*, *B*, and *C* are numbered 1, 2, and 3, but *A* may not be 1, *B* may not be 2, and *C* may not be 3. What number do you think *A* has?"

(If a number above 3 is guessed it is recorded as are other guesses, but the experimenter says, "No; it cannot be above 3 since there are only three letters.") When the number for *A* is found, the experimenter says, "Now what number do you think *B* has?" and when this is found, the experimenter says, "Then what number *must* *C* have?" Whenever the right number of each letter is given, the experimenter says, "Right," and calls the next letter. When it is clear that the subject understands the problem, the experimenter says:

TABLE 12

RECORD OF MR. L. D., A SOPHOMORE STUDENT

Letters	A	B	C	D	E	F	G	H	I	J		Errors		
Numbers	9	6	2	10	8	1	5	4	7	3	UC.	x	*	Total
First series	3	8	5	5	8	7	10x	10x	5x	3				
	5	7	3	7		5	3	3	3					
	1	10	1	10		4	5	1x	7					
	2	3	7			1		7						
	9	1	10					6x						
		6	9x					9x						
			4					2x						
			2					7*						
								9x*						
								2x*						
								4			35	10	3	48
Second series	2	6	10	9x	7	7	7	5x	7	9x				
	6		9x	7	9x	5	3	9x		10x				
	8		2	10	8	3	5	7		6x				
	4					9x		5x*		8x				
	1					1		7*		2x				
	9							9x*		1x				
								10x		3				
								6x						
								9x*						
								6x*						
								4			33	18	5	56
Third series	8	2	10	10	7	1	7	4	3	3				
	6	4	1		5		3		7					
	9	8	8		3		4							
		10	6x		1		2x							
		1	3		8		5							
		7	7											
		8*	5											
		6	8*											
			6x*											
			5*											
			4											
			10*											
			2								30	3	5	38
Fourth series	9	6	2	10	8	1	5	4	7	3	0	0	0	0
Fifth series	9	6	1	10	8	1	5	4	7	3				
			8											
			2								2	0	0	2
Sixth and seventh series correct														
UC. errors	11	12	23	4	6	7	8	20	3	6	100			
x errors	0	0	4	1	1	1	2	15	1	6		31		
* errors	0	1	4	0	0	0	0	8	0	0			13	
Totals	11	13	31	5	7	8	10	43	4	12				144

Note: *UC.* means unclassified errors; x, logical errors; and *, perseverative errors.

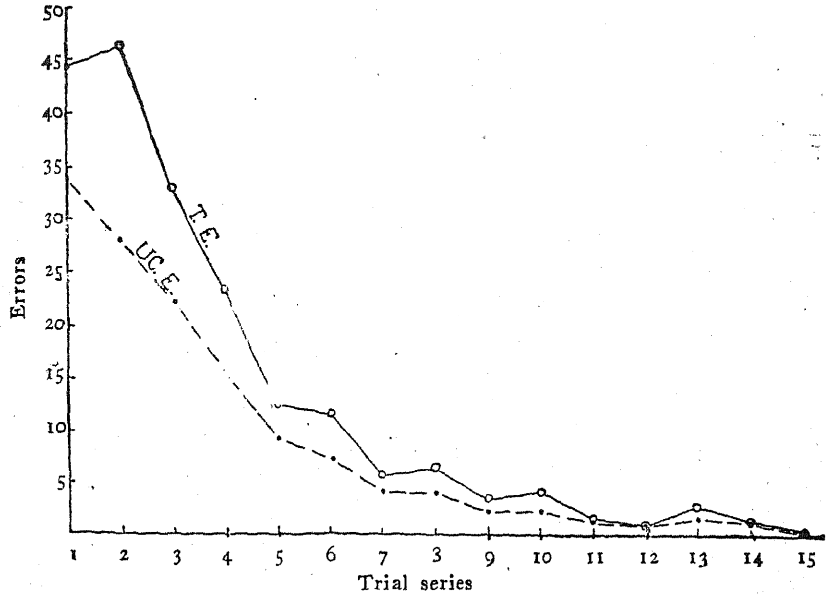

FIGURE 10

RATIONAL LEARNING CURVE, BASED ON AVERAGES OF 19 SUBJECTS

UC.E is the curve of unclassified errors; *T.E.*, that of the total errors. Each trial series consists in guessing numbers for *A*, *B*, *C*, ...*J*.

> "Let us now take all the letters from *A* to *G* (or *A* to *E*) in the same way. The numbers will then go from 1 to 7 (or from 1 to 5). We shall do just as we did before. Let us see how soon you can get all the numbers right."

In the present form, as applied to children, the reliability of this learning test (determined by two different applications) ranges from .56 (on twelve-year-old pure-blood Negro children) upwards, according to the heterogeneity of the group. Tests of pure Negroes on St. Helena Island (Peterson and Telford, 68) indicate that this learning test is less influenced by environmental conditions and specific school training than are certain performance tests used on the same children, and that there is less learning effect carried over from the first to the second application of the test.

Mental-Maze Learning: Race Comparisons of Twelve-Year-Old Children. Peterson (60, 61) has also devised a mental-maze learning problem which has likewise been adapted for use with children and has been extensively applied (Peterson and Lanier, 66). The child is given a card containing Figure 11 and is instructed as follows:

> "The drawing you see here is of a maze. Let us suppose that you are at the beginning but want to go through to the goal. Where would you go if the lines were paths? We shall see how this maze works

TABLE 13

PERCENTILE TABLE OF SCORES IN THE RATIONAL LEARNING PROBLEM, FIVE- AND SEVEN-LETTER FORMS
(Nashville white children)

	Eight-year-olds (5 letters)			Nine-year-olds (5 letters)			Ten-year-olds (5 letters)			Twelve-year-olds (7 letters)		
Percentiles	Min.*	Rep.†	Er.‡	Min.	Rep.	Er.	Min.	Rep.	Er.	Min.	Rep.	Er.
Highest score	2	4	4	1	3	4	1	4	4	2	5	12
90	5.4	8.3	25	5.4	7.6	21	2.4	6.7	10	6.3	7.4	37
80	7.9	11.3	43	7.6	10.9	37	4.8	8 7	21	7.5	9.0	60
75	9.1	12.5	52	8.7	12.2	45	5.7	9.6	26	8.0	10.0	66
70	10.3	13.7	63	9.8	13.5	53	6.6	10.8	37	9.2	10.7	72
60	12.4	16.7	84	11.9	16.6	70	8.3	13.4	52	10.2	12.0	88
50	14.6	20.5	114	14.0	20.5	96	10.0	16.3	69	11.2	13.1	100
40	17.7	24.9	128	17.4	24.7	135	12.4	19.7	84	12.2	14.2	112
30	22.0	31.4	166	24.8	32.3	198	14.8	22.5	99	13.5	15.4	130
25	25.0	34.5	188	31.7	37.5	235	16.6	23.8	115	16.0	16.0	142
20	33.5	40.3	228	37.8	45.3	260	18.5	25.6	135	16.8	16.8	148
10	40–	55.3–	465–	40–	53.3–	410–	33.0	39.0	220	21.0	18.8	230
Lowest score	40–	106–	1045	40–	106–	1155	36	123	1162	49	27	315
Number of children		108			84			82			60	

*Minutes
†Repetitions
‡Errors

Note: These children were all selected according to age from representative schools in Nashville, irrespective of grade classification. Eight years of age means 8.5 years, and so on, since age was determined by the last birthday. Norms for the eight-, nine-, and ten-year-olds are from an earlier study (Peterson, *62*). The practical equality of the eight- and nine-year-olds is probably due to a *tendency for* the duller children not to enter school until after the eighth year. The twelve-year-old *norms* are from a more recent study (Peterson and Lanier, *66*, p. 68). The fore-exercise was not used when these tests were given.

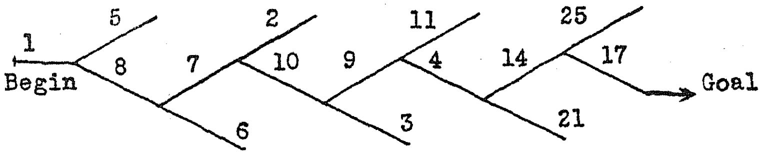

FIGURE 11
THE SAMPLE "MENTAL MAZE" WHICH THE CHILD WAS GIVEN TO STUDY AND WHICH HE KEPT BEFORE HIM DURING THE EXPERIMENT

> out and then you will try to go through another one just like it. Let us begin at 1. I shall call out two numbers for the first two paths and you are to choose one of them. Then I shall call out two more numbers and you choose one of them; and so on until you reach the goal."

In the fore-exercise the experimenter gets the subject to the goal and makes sure that the problem is clearly understood by the subject. Additional appropriate instructions are given to him, and pairs of words which are opposites, such as *white-black, night-day, right-left,* etc., are substituted for the successive pairs of numbers. The subject does not know, of course, which word is associated with a blind alley at any of the successive points of choice, but he is permitted to keep the maze with

TABLE 14
PERCENTILE SCORES BY TWELVE-YEAR-OLD NASHVILLE CHILDREN IN THE MENTAL-MAZE TEST

	Minutes		Repetitions		Errors	
Percentiles	Whites	Negroes	Whites	Negroes	Whites	Negroes
Highest score	1	1	3	3	2	2
90	2.36	2.63	4.31	4.63	5.45	5.75
80	2.99	3.43	5.26	5.88	8.29	8.64
75	3.30	3.83	5.74	6.41	9.70	10.10
70	3.62	4.37	6.22	6.91	11.47	11.65
60	4.32	5.69	7.17	7.93	15.33	14.77
50	5.14	9.50	8.19	9.88	21.25	23.13
40	5.96	13.16	9.68	14.80	26.17	44.33
30	7.61	16.93	12.58	18.85	37.36	56.70
25	8.50	20.00	14.05	20.50	42.25	63.75
20	9.42	23.07	15.13	21.66	49.00	74.50
10	12.73	40+	20.37	27.93	77.75	99.75
Lowest score	38	40+	27	43	215	189
Number of children	119	87	119	81*	119	81

*Six Negroes failed to complete the mental-maze test. The percentile scores for Negroes are therefore better than they would be if these children had been held till they had completed the test. The race differences represented in this table are, therefore, slightly too small.

numbered parts as shown in Figure 11 before him and to look at it as much as he desires to during the learning. Three different series of paired words are used in rotation when several children of any school group are tested so that any possible attempts at coaching the untested by the tested will be frustrated. The problem is solved when the subject has reached the goal twice in succession without any error. The total number of minutes, of errors, and repetitions constitute the score. These for twelve-year-old children are reduced to percentile scores by reference to Table 14, and the percentiles are averaged to give the subject his score. Norms for other ages are not yet available. The crucial point in this learning exercise is for the subject to note that whenever his choice results in the calling of two new numbers (or of two new words) he is on the right path, but if only one new number or word occurs in the next alternative presented he has made an error (the reader may verify this by reference to the figure). When the subject discovers this principle, learning proceeds rapidly. It is interesting to note, however, that in a number of cases both children and adults have learned to follow this principle without recognizing it explicitly.

Learning When Frequency and Recency Factors Operate Negatively. Another procedure with this mental-maze problem has been devised (Peterson, 61) in which the choice begins anew at the first division in the maze whenever an error is made in any blind alley. This shift is made without calling the subject's attention to the fact, and a chance-order schedule regulates which alternative—the right or the wrong one—is to be called out first in each pair, so that no fixed procedure which the subject may learn can work. In such a situation, both frequency and recency factors operate against learning, since the subject must learn to break away from erroneous choices against frequency and recency expectations. Thus (referring to Figure 11), if 6 is chosen, the subject, to learn, must choose 7 against both frequency and recency effects. It has recently been found both on adults and on a few children that learning goes on in spite of this opposition to frequency and recency effects. Similar results were earlier obtained on rats (Peterson, 57).

Experiments are now in progress in which punishment for right choices is also given in this modified mental-maze procedure, the object being to test the efficiency of the factors of *frequency, recency,* and *sensory effects.* Learning goes on in the more mature individuals, it is found, even when frequency and recency factors operate negatively and punishment (an electric shock) is inflicted when right choices are made. Whether this is true in the case of infants and young children is doubtful. Experiments on such subjects have not yet been carried out. A different sort of experimental set-up is required for them.

Learning the Meaning of Opposition: "Insight." Kreezer and Dallenbach (42) attempted to find out *when* children learn the meaning of opposition, and *how* they learn it—by "trial and error" or by "insight"

—and at what age they are *capable* of learning it. They experimented with 100 children (43 girls and 57 boys) selected wholly on the basis of age. There were twenty children in each of five age groups ranging in half-year steps from five years through seven and one-half years. Each child not knowing the meaning of opposition was taken individually through a series of questions beginning (after preliminaries) with "Do you know what opposite means?" He was then asked for the "opposite" of good and of big (being told when he failed that *bad* and *little* were the opposites); and he was finally required to give the opposites of *white, short, fat, wet, glad, hard, in, slow, weak, open, heavy, up, smooth, little, sleep, shut, strong, quick, out, soft, sad, dry, thin, long,* and *black.* In the case of these last twenty-five words, the subject was told simply whether he was right or wrong. If the first ten of these showed that he did not understand the relationship, the experimenter again told him the opposites of *good* and *big,* and repeated in order for the subject's responses these ten words, continuing through the entire list. In an earlier study by Dallenbach (18), a six-year-old child who did not understand the meaning of opposition at first "learned it immediately upon gaining 'insight' into the problem," whereas a three-year-old child did not learn the meaning by the method of help described. In the more recent experiment on the one hundred children it was concluded that "all the *S*s who learned the relation learned it immediately with a sudden acquisition of insight." Even those children who learned it in the latter part of the experiment, where opportunity for gradual learning was afforded, "exhibited the same sudden shift from free chance association to association determined by the relation of opposition. None of our *S*s exhibited a gradual acquisition or understanding of the relation. The curve illustrating their progress in learning dropped abruptly from 100% failures to 0%" (p. 436). Thirty-one subjects were totally unsuccessful, none of them "showed any progress toward learning." Those who learned show no "tendency of retrogression or forgetting. . . . Learning by insight appears to be immediate—a case of 'all-or-none'—and also permanent." The results show that the following percentages of children in the successive age groups from five to seven and one-half years understood, or came to understand during the experiment, the meaning of opposite: 40, 60, 75, 80, and 90. "Insight" is, of course, no explanation of learning: as used by Dallenbach, it simply means that, with the gross methods of measurement of success used, responses giving proper relation came suddenly. Probably minor processes or habits were gradually forming and all together rather suddenly became effective in the total act scored (cf. Peterson, 58, 64).

The study of problem-solving by Alpert (1*c*) carried out on forty-four children, ages nineteen to forty-nine months, employing the methods used by Köhler on chimpanzees, brought out certain criteria of "insight"—changes in facial expression and posture, in tempo and precision of work, in vocalizations, transfer and retention, etc.; but "insight" seems to have

emerged with implications of directive powers rather than as itself a better defined and better understood response resulting from the learning. The correlation between achievement and MA was only .27. Matheson (46*a*), in a similar study in which twenty-eight preschool children (30 to 54 months of age) were individually placed into five different situations duplicating those of Köhler's experiments with apes, found not only a wide variability of responses but the presence of the more general of them (e.g., trial-and-error manipulation and discouraged attitudes) in all the situations. The older and brighter children were superior. The value of such tests with very limited control depends much on the sort of problems undertaken: They are probably most useful if situations are well chosen for explorations of children's resourcefulness.

Aldrich and Doll (1*a*) have put eight idiot boys (ages 8.6 to 11.9 years, MA 1.6 to 3.2 years) through three successive box-piling and climbing problems to secure the lure (a big ball, a cookie, a banana, etc.) suspended from the ceiling, involving successively one, two, and three boxes. A trial was limited to approximately 10 minutes and the same problem was presented until there were three consecutive successes. In case of five successive failures the problem was somewhat simplified and the lure strengthened. Problem I was solved by six, Problems II and III each by five of the boys. Marked individual differences in resourcefulness were noted. A further study (1*b*) indicated that idiots of about the same mental capacity as indicated above could obtain the lure with a hooked stick (only one failed), but that the more difficult problems (joining of two sticks or the use of a second stick to obtain the long one) were solved only by idiots of about three years mental age. Marked differences were manifested, and the idiots showed the sudden solutions regarded by Köhler and Alpert as evidence of "insight." Aldrich (1) finds that these idiots are not sufficiently differentiated by intelligence tests to account for their varied abilities in the problem-solving tests already referred to.

An intensive, well-controlled experiment by Munn and Stiening (52*a*) on a fifteen-months-old child is of considerable interest. A choice apparatus with two doors bearing different visual patterns, interchanged in a chance order to prevent space habits, was used. Candy was the reward for correct responses, and, after 100 trials, the wrong door was locked each time. Possible odor of candy and other "irregular" factors were controlled. The first problem was to distinguish between a black cross in a white diamond (associated with the candy, i.e., the positive signal) and a small black square on the same sort of diamond, both diamonds being set in a larger constant black square as background. These signals were distinguished in 400 trials—10 per day. Various changes in the positive signal, even to rotating the cross 45°, accompanied by five variations in the background and five in the negative (to-be-avoided) signal were presented in a series of tests in which either the positive or the negative signal might be varied. Results showed, and they were later confirmed, that the child was responding to the form of the signal *per se* re-

gardless of its position in space, its background, or its relation to the negative signal. The senior author had failed to get such responses with chickens.

Children's Thinking Compared with Adults' Thinking

Hazlitt (31) has recently reported experimental results on children's thinking, which, she contends, do not support some of the conclusions and assumptions of Piaget's work, that up to about the age of seven years the child's thinking differs fundamentally from that of the adult. Her tests of Piaget's conclusions—that these young children cannot express verbally relations such as that of exceptions (cutting out an individual or a group from generalization), and that they tend to generalize from single examples—are valuable contributions both in suggestions as to method and in the results obtained. In her preliminary statements she points out that even though Piaget admits that certain assumptions are not justified, he nevertheless bases conclusions on them. These assumptions are "that thinking can be identified with ability for verbal expressions" and "that the matter of thought is indifferent to the process" (e.g., that, if a child cannot think a relation in regard to one subject-matter, he cannot think it in regard to another). Here are some of her experiments stated briefly:

Making Exceptions. Colored and ornamental cards are mixed with fifteen black cards, five of which are of a smaller size. The experimenter tells the subject that some of these cards are called *K*, and that he must notice, as she puts the pack down one by one, which ones she calls *K*. The experimenter then proceeds, calling out "*K*" each time that she puts one of the large black cards down at the subject's right, and keeping silent as the small black cards and the colored and ornamental cards are put down at the subject's left. The cards are then all shuffled again and dealt out one at a time, the subject being instructed to call out "*K*" for the right cards. Some of the children did not try and others who tried made errors. All who succeeded were asked how they would tell someone else which were the *K*'s. Here is a "typical" conversation. *S:* "The blacks are K." *E:* "All the blacks?" "Yes." "Is this small one *K*?" "No." "Is it black?" "Yes." "Then are all the blacks *K*?" "Yes." Though they could apply the exceptions practically, the subjects could not formulate them verbally even with such aid. Only bright seven- or eight-year-olds responded, "All the blacks except the little ones are *K*." The youngest children, apparently around three years of age, could not even complete this sentence if *except* were omitted and they were asked to choose the word or words that would give the best sense from *although, except,* and *but not;* they would agree to any of the three. That is, of course, not surprising of such young children.

Making Generalizations. The youngest children were presented successively with four trays of toy objects containing *dog* and *bird, dog* and

pig, dog and *cow,* and *dog* and *sheep,* respectively. Another series contained successively *man, hunter, can,* and *goose* with a *matchbox.* Both sets of material were used with all the children to insure as far as possible that responses were not due to any particular objects used. To questions like "What have all the trays got?" "very few" children under five years could pick out the common element in either of the series. In working with the children, the author found reason for holding the view, but gives no evidence, "that the realization of sameness in difference is an experience that comes more or less suddenly to the child, and that in some it does not come much before three years" (p. 358). In further experiments on generalizing from certain particulars to others similar to them (suggestive in method to others who may use better objectivity and give results in statistical terms), Hazlitt presented individually to children "thirty cards of different colors, some plain, others marked with gilt moons and stars in different arrangements. The child was told that two which were shown to him were called A. One of these was blue with a moon and star upon it, the other was yellow and similarly decorated, except that the moon and star were not in exactly the same relative positions. He was then asked to pick out all the other A's from a pack, none of which was identical with the blue or the yellow as to the arrangements of the moon and star." The youngest children, to attempt a solution, picked out all the cards with marks of any kind, leaving only the plain ones. Slightly older ones picked only those with one moon and one star, leaving the plain cards and also those with other marks, such as two moons and three stars. All these children chose without reference to color. An "exceptionally bright" six-year-old boy chose only blue and yellow cards with a moon and star. The "brighter children" of seven and eight years tried to take into account in their choices only those cards which had the moon and star in the same relative position as in the samples but on any background, whereas some of them seem also to have required that the cards have the same colors as the samples. Thus the older the children, the narrower the basis chosen for their generalizations.

Piaget's Experiments Applied to Non-scientific Adults. Finally, the experimenter repeated on non-scientific adults some of Piaget's experiments on children as to physical causality and found on them "exactly the same results" as those reported by Piaget. It is desirable that both of these investigators adopt better procedures, reporting the number of cases, detailed responses, etc., and using objective and control methods with statistical presentation of results.

Generalizing in the Disc-Transfer Problem

Another learning problem of a quantitative nature is that called the disc-transfer test (Peterson and Lanier, 66). The experimenter, on a rectangular piece of panelling, about 6 x 8 inches, has painted in different colors three circles, 1, 2, and 3, in the position shown in Figure 12, each

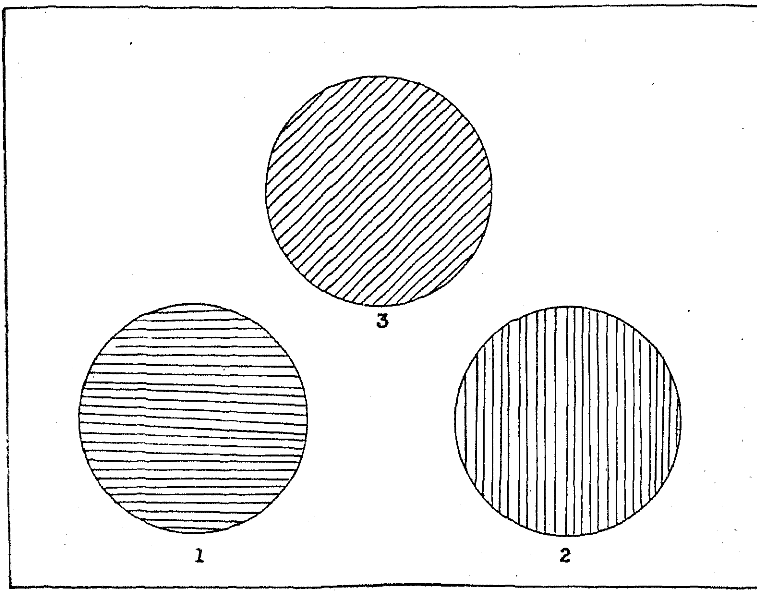

FIGURE 12
THE DISCS ARE TO BE TRANSFERRED TO CIRCLE 3 FROM CIRCLE 1

circle being 2½ inches in diameter. Five wooden discs, decreasing successively in diameter from a little less than 2 inches to about ¾ inch, are stacked on Circle 1, in such a way that no disc is on top of a smaller one than itself. In the fore-exercise only the three largest discs are used, and the experimenter says to the subject:

> "You are to get these three discs over to Circle 3 in the same order as that in which you see them now. You must move only one disc at a time and never place any disc upon a smaller one. You will have to use Circle 2 as a relay station. Let me show you how to do it."

The experimenter then puts the smallest disc in Circle 3 and the next in Circle 2. The smallest is then placed on the one in Circle 2, the largest one moved to Circle 3, the smallest to Circle 1, the medium one is put on the largest one in Circle 3, and the smallest one is, in turn, put on it, when the problem is solved. Then the three discs are again stacked on Circle 1, and the subject is told to solve the problem as he has just seen it solved. When he can go through it without an error, he is given four discs. Finally five are used. The last two solutions are regarded as tests of the subject's ingenuity. The time in minutes and the number of moves constitute the scores. The experimenter keeps careful record, however, of all three solutions and of the subject's general method of behavior. No move is counted unless the disc is definitely released by the subject.

TABLE 15
PERCENTILE SCORES OF TWELVE-YEAR-OLD CHILDREN IN THE DISC-TRANSFER TEST

	The four-disc form				The five-disc form			
	Minutes		Number of moves		Minutes		Number of moves	
Percentiles	Whites	Negroes	Whites	Negroes	Whites	Negroes	Whites	Negroes
Highest score	1	1	17	18	1	2	37	41
90	1.52	2.94	21.50	26.60	2.83	3.84	47.42	51.45
80	2.03	4.02	25.88	34.33	3.32	4.93	60.40	59.27
75	2.24	4.38	27.73	36.94	3.51	5.34	63.38	64.38
70	2.45	4.73	29.59	39.33	3.70	5.74	66.35	69.75
60	2.88	5.42	34.82	42.47	4.16	6.73	73.29	79.33
50	3.33	6.14	42.25	45.63	4.91	8.30	82.50	86.67
40	3.79	7.37	47.67	51.60	5.95	9.52	96.29	101.50
30	4.42	8.53	52.42	56.86	7.21	11.13	115.50	120.18
25	4.82	9.25	54.71	58.39	7.75	11.75	125.42	124.09
20	5.29	10.56	59.33	59.93	8.53	12.87	135.33	128.00
10	6.51	13.70	73.88	77.40	11.37	16.33	163.67	157.00
Lowest score	17	23	243	95	21	30	386	200
Number of children	119	86*	119	86	119	86	119	86

*All whites completed the test in both forms; two Negroes failed to complete the four-disc form, and four failed to complete the five-disc form of the test. See notes under the previous table.

Percentile norms of twelve-year-old white and Negro children are given in Table 15. It is obvious that this problem can be increased in difficulty through different degrees. The number of moves required for one disc is 1; for two, 3; for three, 7; and for four, 15. In general, the number of moves for n discs equals 2 to the nth power minus 1 (2^n-1). Ten discs would require 1023 moves; twenty, over a million; and thirty, over a billion. An observant subject learns to anticipate how to place the beginning disc so that the largest one, in its turn, can be moved directly into Circle 3. More advanced subjects can formulate the general principle by analyzing the processes into fundamental elements to which others are added with the use of more discs. With odd numbers the first move goes to Circle 3, with even to Circle 2, but caution is necessary if one is to avoid extra moves and confusion. The reliabilities of this learning problem and of the mental maze have not yet been determined.

GENERALIZATION AT DIFFERENT LEVELS: BRIGHT CHILDREN VERSUS ADULTS

A learning process, involving generalizing at different levels, which may be valuable because of its objective and quantitative nature and its constant stimulation at successive stages similar for all subjects, was probably first introduced into psychology by J. C. Peterson (69), and later used

on adults in a study of the influence of tuition on learning by Waters (82). The method can be applied in its simpler form to children above the age of about ten years. The experimenter presents to the subject seven beads on a string and instructs the subject so to manipulate his draws as always to take the last bead. The experimenter and the subject draw alternately either one or two beads. It is understood that the experimenter will take advantage of any error made by the subject so as to prevent his having the final draw. If, e.g., *S* draws 1 bead, *E* will take 2, leaving 4, then, if *S* takes 2, *E* will take the last 2 and win; but if *S* takes 1, he can win by taking 2 the next time if *E* takes 1, and 1 if *E* takes 2. When the subject has taken the last bead three times in succession, the experimenter presents eight beads, and when this problem is solved the experimenter presents ten, then eleven, then thirteen, etc., until the subject can formulate the general principle or indicate how to draw from any number so as always to win. Multiples of three are not represented, since problems of this sort cannot be won, but the subject must infer this latter fact himself. The subject, therefore, must always draw the first time so as to leave the experimenter a number that is a multiple of three. If harder problems are within the range of the subjects to be tested, the experimenter and the subject may each draw one, two, or three in a second series of draws from seven, eight, nine, ten, etc., beads, as before. In such a series, the numbers which the subject must force upon the experimenter in his first draw are multiples of 1+3, or, in general terms, when choices may go higher than 3, multiple of $L+H$ (lowest+highest)

TABLE 16

SUMMARY OF THE RECORDS MADE BY K AND J IN THE J. C. PETERSON GENERALIZATION PROBLEM

Series	No. of trials K	No. of trials J	No. of problems solved K	No. of problems solved J
1 – 2	34	34	9	17
1 – 3	13	18	6	6
1 – 4	1	0*	1	0
1 – 5	0	0	0	0
2 – 3	4	17	2	10
2 – 4	3	–†	2	–†
2 – 5	8	4	2	2
3 – 4	2	10	2	8
3 – 5	3	0	1	0
3 – 6	0	0	0	0
5 – 6	1	0	1	0
3 or 1	6	5	4	5
2 or 6	22	8	16	8
3 or 9	13	6	9	9
2 or 7	36	14	21	16
Totals	146	116	76	81

*Zeros indicate that the generalization in the series was given immediately or without any draws.

†Accidentally omitted.

draws permitted. Higher problems of both the "continuous" and "discontinuous" sort are possible by gradations suitable for subjects of greater maturity, as Peterson has shown in the monograph cited. When draws of 1, 2; 1, 2, 3; 1, 2, 3, 4; etc., are permitted, the problem belongs to the continuous series; when only L or H may be drawn and these are not 1 and 2, the problem is classified with the discontinuous series. Complete, objective records of draws are possible in this learning process and all of the subject's remarks and indicated attempts at generalizations may be recorded on a time scale by means of a metronome and a dictaphone.

Two superior boys of ages eleven and thirteen years, respectively, were included in Peterson's subjects. These boys made very superior records, even when compared with his adults, and they showed no handicap by the lack of higher education, as compared with the college students. The eleven-year-old boy's record practically equaled that of his father, a Ph.D., and their methods of arriving at the successively higher generalization through 76 (son) and 81 (father) problems in 146 and 116 trials, respectively, were not noticeably different (see Table 16). This technique seems to have value in problems relating to hereditary and environmental influences on children's learning.

General Conclusions

This survey of experiments on learning in children has revealed considerable similarity between such learning and that in adults. Detailed differences at different levels of maturity and on specific problems have not yet been worked out experimentally to any considerable extent. Such differences have not particularly interested the investigators up to the present time. Many difficulties still lie in the way of such experimentation—difficulties of equating motivation factors, of controlling acquired sets and general carry-over effects of past general experience, of making apparatus equally usable by children of different age levels and of correspondingly different degrees of coordination, etc. Such specific experimental contributions are, however, sure to follow with progress in this field of psychology. Both in the acquirement of new motor coordinations and specific skills and in the rational organization of responses to complex problems involving generalizations on successively higher planes, there is much similarity between children with language habits and adults. At no level of growth do sudden and marked differences in learning appear. Children, however, are less cautious in maze problems and various multiple-choice situations. They probably react more unrestrainedly to mere parts of situations and less integratively and consistently to the whole experimental situation before them than do adults, speaking generally; hence, in coordination and orientation problems, their error and excess time (or distance) scores are at first large and their learning curves consequently drop more rapidly in early trials when plotted on an absolute scale, while, in rational-organization problems, older individuals eliminate errors

more rapidly than younger subjects. Children seem to show less transference of learning from one situation to another—in different terms, they generalize less readily or accurately on the more rational problems—but there are great overlappings between groups of different age levels. Several investigations indicate that the difference is less one of experience and maturity than of mental-age level, but present evidence also indicates marked maturity effects in the development of early coordinations.

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CHAPTER 11

CHILDREN'S MORALS

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THE PROBLEM IN THE STUDY OF MORALS

The study of morals is a study of that phase of behavior where the rightness or wrongness of response is judged in relation to standards which aim to be the consistent correlatives of certain values. Since the terms right and wrong may be used in two separate senses, it is necessary to distinguish between right and wrong as referring to moral evaluation of responses, and right and wrong as referring to truth or fact. A child who multiplies five by zero and gets five for an answer has made a wrong response. It is wrong, however, not on any moral score but on the basis of a known relationship. In the study of knowledge and intelligence we are concerned with the adequacy of response to situations on the basis of truth or fact,[1] whereas in the study of morality we are concerned with the adequacy of response as judged by a personal and social standard, which depends in turn upon what man values in the world. In determining what man's ultimate values are, one has the same difficulty as in determining what ultimate truth is. Indeed it would seem that, if we understood what the truth in its fullest sweep was in ordinary responses, we would have no occasion to make a distinction between right and wrong on the basis of truth and fact and right and wrong on the basis of moral values. But, since the adequacy of response to every situation must be given not on the basis of ultimate truth but on very limited fact, it is very important to have the additional criterion of moral adequacy. In the complex situations which children face we are concerned not only with those responses which, on the basis of existing knowledge, may be pronounced to be successes or failures and to reflect high or low intelligence, but also with those responses which, on the basis of accepted standards, may be said, in non-technical language, to reflect right or wrong motives or right or wrong senses of values. This does not mean that values are static over any period of time; indeed, much of the discussion to follow will go to show that both social standards and individual values change. The point here is that to speak of moral behavior we must assume the existence somewhere of a standard of value for that moment.

In a study of children's morals where the aim is to include the maximum of concrete data and the minimum of abstract speculation, as is the aim in this chapter, it is necessary to confine oneself as closely as possible to

[1]Thorndike (67) says: "We may define intellect in general as the power of good responses from the point of view of truth or fact."

measurable behavior. If one is interested in building theories or in interpreting facts in terms of some theory already accepted, there is ample opportunity for such in the interpretation of the responses of children in situations involving honesty, truthfulness, and the like. There is, for example, the very difficult problem of the source of values; there is the problem of the degree to which deliberate choice enters into the conduct of children in moral situations. These and other similar problems calling for analysis are extremely important and deserve to be brought out of the realm of speculation and into the field of experimental study. However, speculation still reigns supreme in such problems, due to the impossibility of measuring and controlling the variables in a manner required for any scientific study. But considerable inroads have been made by those using the objective method into many angles of the field of morals. The behavior of children has been studied by means of tests and rating scales in situations involving cooperation, generosity, honesty, persistence, self-control, truthfulness, and the like. There has also been a large amount of statistical and experimental work done in comparing the responses of delinquent and non-delinquent children. It will be the aim of this chapter to bring together the most significant facts from such studies and interpret them as best we can in the light of modern psychological principles.

Individual Differences in Moral Behavior

One of the first facts which one notes in the inspection of the behavior of children in controlled situations involving a moral problem is that they do not fall into two groups: the good and the bad, or the truthful and the untruthful. There are individual differences in morals just as truly as there are individual differences in general intelligence or in knowledge of history. In a scale of truthfulness, for example, children have been found to distribute themselves from the end representing great deceitfulness to the end representing great truthfulness. Moreover, there is no place on this scale where one can, with any factual justification, draw a line which can be said to separate the untruthful from the truthful. At first glance one might suggest drawing the line at the truth, the whole truth, and nothing but the truth. Such a standard can be defended in some of the simpler situations, and if we make truthfulness coextensive with truthfulness in certain simple situations, then we do find a considerable number who would satisfy this standard. But such a line or standard cannot be set up for practical usefulness in the distribution of truthfulness taken in its wider meaning, because it would not hit within the distribution of normal children. To see the justification for this statement, one has only to think how the various moral traits—if we consider them for the moment as unities—get in one another's way. Truth-telling at times conflicts with loyalty to our group; truth-telling to the limit may conflict with courtesy and gratitude to our host or benefactor; truth-telling to a sick person may conflict with helpfulness.

Nature of the Distribution. An actual distribution of a large number

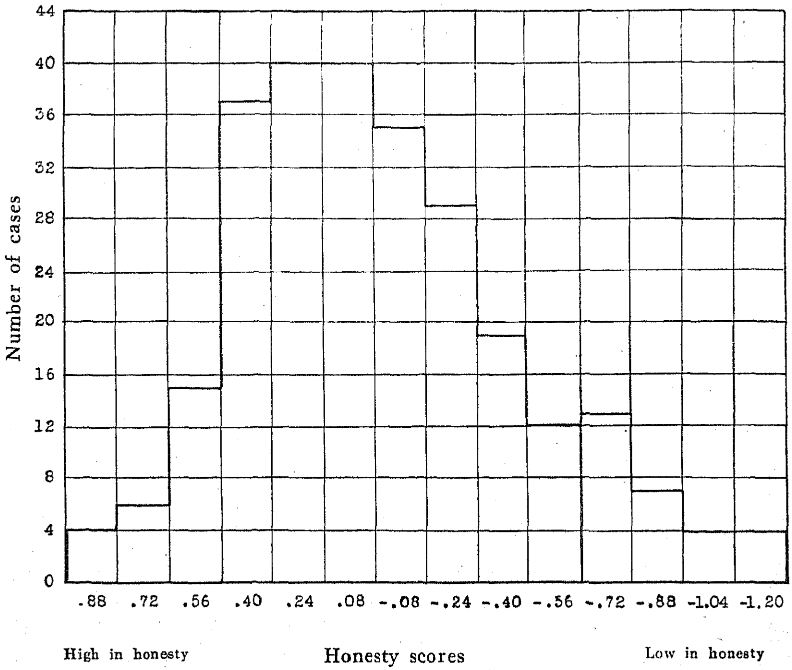

FIGURE 1

DISTRIBUTION OF HONESTY SCORES FOR 265 CHILDREN, THE SCORE FOR EACH CHILD BEING THE MEAN ON 21 TESTS

(Based on data from H. Hartshorne and M. A. May's *Studies in the Organization of Character*. New York: Macmillan, 1930, pp. 480, 486.)

of children on twenty-one tests of deceitfulness is given in Figure 1. These tests are not measures of what children say about what they would do in such and such situations; they are tests of what they actually did. From Figure 1 it is seen that the range is from the very deceitful to those high in honesty and truthfulness. The distribution is continuous, with pupils scattered all along the line. No children achieved the highest possible score. Zillig's (80) results in the study of truthfulness among children of the primary grades are in agreement with this conclusion. She submitted a group of children to some rather complex situations and found that no child examined was entirely truthful.

The distribution in Figure 1 is typical of what we would find in a random sampling of public-school children of Grades 4 to 8 when a large number of tests are given and the motivation is rather strong. In a selected population, where a very few tests are used and where there is little or no motivation, the distribution may be quite different, and many perfect scores may be obtained. Figure 2 gives a distribution based on 2443 children where each had 10 tests and where the total motivation was not so strong as in the battery of tests upon which Figure 1 was based.

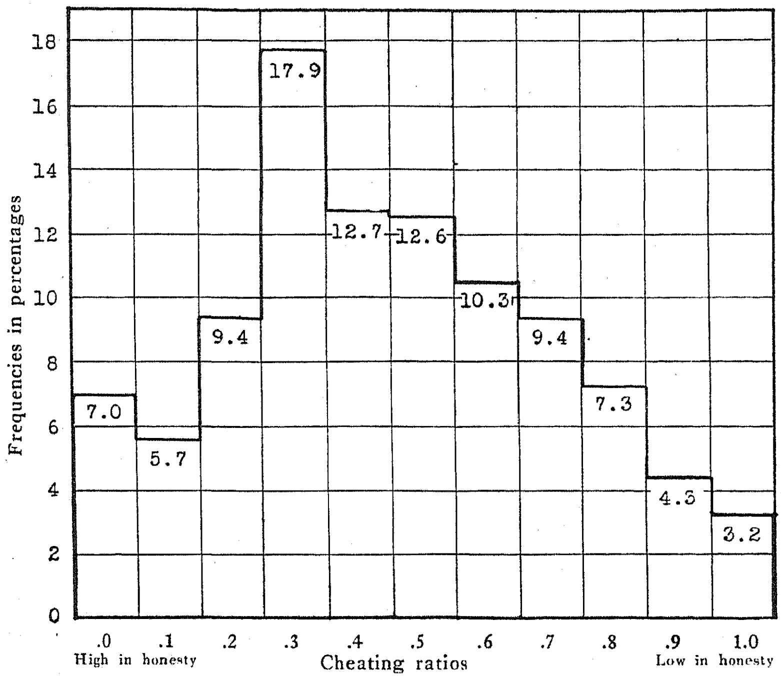

FIGURE 2

DISTRIBUTION OF CHEATING RATIO SCORES

Frequencies given in percentages. Number of cases=2443. Grades 4-8. The cheating ratio is the ratio between number of cheatings and the chances to cheat. Each child was measured on 10 tests.
(Based on data from H. Hartshorne and M. A. May's *Studies in Deceit.* New York: Macmillan, 1928, p. 386, Part 1, and p. 220, Part 2.)

The general shape of the distribution is the same as that of Figure 1, except that 7 per cent made perfect scores.

The responses of children in situations which were much less complex than these two were studied by Slaght (58). He set out to determine the degree to which children would cheat in taking an examination and in scoring their own papers, the degree to which they would surreptitiously increase their score by peeping, and the degree to which they would tell a clean-cut falsehood to cover up their guilt. In such cases, where the issue seems to be so obvious to everybody, we should expect a considerable number of the children to make perfect scores. This is precisely what Slaght found. Out of the 351 children whom he tested, of Grades 4 to 10, 7.1 per cent cheated on all three different tests which he used and, in addition, lied about it; 15.1 per cent cheated on two tests and lied; 19.1 per cent cheated on one test and lied; and 58.7 per cent were honest on all three tests.

In considering individual differences in the population in a moral trait

such as honesty or truthfulness, it must be remembered that the complexity of the situations presented and the motivation will influence the form of the distribution. But, if the test situations are really complex enough to measure the individual, and if the motivation given for dishonesty or untruthfulness is strong, then the distribution is continuous, extending from scores representing very low honesty or truthfulness to scores representing very high honesty or truthfulness.

Distributions based on a rather thorough testing of a large sampling of the population are available for a few other traits, such as helpfulness and persistence. In every case the distributions obtained are very well typified by the two distributions already given. However, since both of the other distributions were for a mixture of truthfulness and honesty, it may be well to include one more for purposes of comparison. Figure 3 represents the distribution of total scores from five tests of helpfulness devised and given by Hartshorne and May.

Measurement of all the various aspects of children's morals has not progressed far enough yet to enable one to combine results into a general morality score corresponding to a general intelligence score. Indeed, it is not certain that any such score would be desirable. However, since all the distributions available for separate traits indicate a continuous spread from lowest to highest, and since we do not find any traces of negative correlation among desirable traits, it seems fairly certain that the scores from the most comprehensive battery of tests which could be given today in the field of morals would distribute themselves in a manner approaching a normal distribution curve. This generalization is not based on the conception that the scores yielded by such an instrument would represent greater and lesser amounts of the same thing, but rather on the conception that the scores represent samplings of a multitude of factors.

Methods of Measurement

Tests. Since test scores cannot be interpreted apart from the tests upon which they are based, it will be necessary to give some facts about the most successful measuring instruments which have been used in connection with children's morals. The measuring techniques which have been employed with greatest success can be grouped under three headings: first, the measurement of actual behavior; second, measurement of knowledge and attitudes; and third, rating scales.

One of the most interesting and convincing measures of moral behavior has been the tests of actual performance. Voelker (73) was a pioneer worker in this field, though it should be noted that his work was done just ten years ago. He devised ten tests of trustworthiness, several of which, in revised forms, have been used very widely. Then came the work of Cady (9) in 1923, who, building upon the work of Voelker, made a battery of five tests. Since that time, important contributions in the devising and standardizing of tests of actual conduct have been made by Raubenheimer (51), Henning (31, 32), Hartshorne and May (25-27),

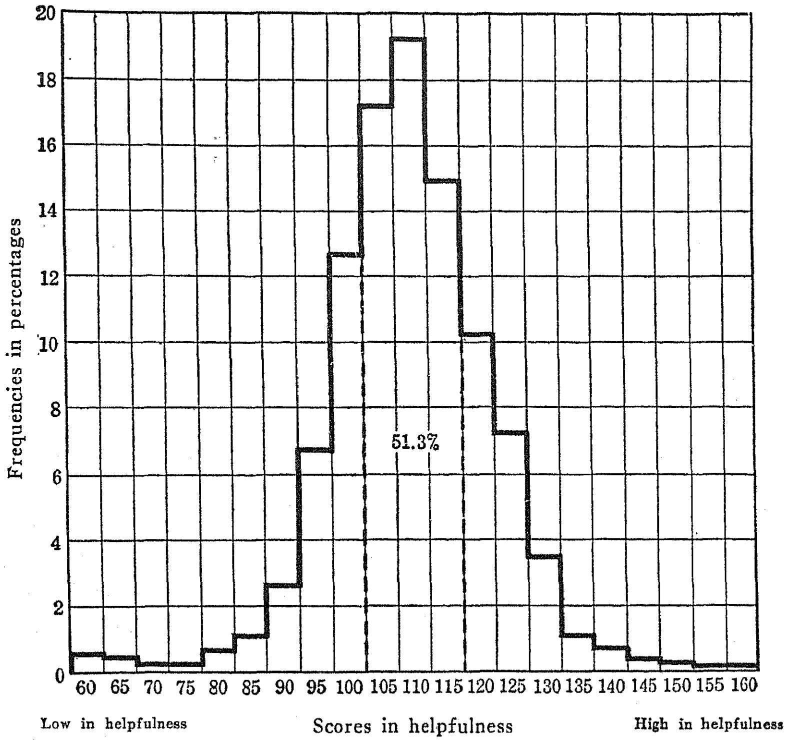

FIGURE 3
DISTRIBUTION OF TOTAL HELPFULNESS SCORES
Frequencies given in percentages. Number of cases=800.
(From H. Hartshorne and M. A. May's *Studies in Service and Self-Control.* New York: Macmillan, 1929, p. 109.)

and others. Table 1 gives a summary of the tests which have been used, the investigators who have used each, and all available facts on the reliability and validity of each.

The second set of measures which have been used in the study of moral behavior is composed of tests of knowledge and of attitudes.[2] A summary of these tests is given in Table 2.

Rating and Ranking Methods. The oldest device for measuring children's morals is some form of rating or ranking. By use of the best methods of rating and by combining the results from several raters, it is possible to get rather reliable measures of some traits. Some of the reliabilities of ratings reported in the literature are as follows: .40 to .80 (Barr, 4); .52 to .87 (Freyd, 19); .65 to .81 (Webb, 78); .80 to .90 (Cleeton and Knight, 11); .62 to .91 (Shen, 55). The differences in

[2]The reader who is interested in the theoretical and technical aspects of the measurement of attitudes will find an excellent treatment given by Thurstone (69) and by Thurstone and Chave (70).

TABLE 1

TESTS OF ACTUAL PERFORMANCE IN MORAL SITUATIONS WITH NAMES OF EXPERIMENTERS AND FACTS ON RELIABILITY AND VALIDITY

	Reliability	Validity	Experimenters using the test
Honesty—Dishonesty			
1. Not returning overchange	—	—	Voelker
2. Not returning borrowed property	—	—	Voelker
3. Not returning extra dime found in testing materials	—	—	May and Hartshorne
4. Not returning all coins used in test	—	—	May and Hartshorne
5. Cheating in taking an examination (6 tests)	.83	.91	May and Hartshorne
6. Cheating in scoring one's own paper as shown by comparison of carbon or wax copy of original with corrected copy	.58 (C)*	.19 (C)	Voelker, Cady, Slaght
7. No. 6 revised and lengthened (3 copying tests)	.87	.93	May and Hartshorne
8. No. 6 revised (6 speed tests)	.83	.91	May and Hartshorne
9. Cheating in keeping one's own score in an athletic contest (4 tests)	.77	.88	May and Hartshorne
10. Peeping in task which was to be done with eyes closed. Tested by success at impossible task. May and Hartshorne used 3 tests	.74 (C) .72 (M-H)	.40 (C) .84 (M-H)	Voelker, Cady, Slaght, May and Hartshorne
11. Unfair methods used in party games (4 tests)	—	—	May and Hartshorne
12. Faking solution to a puzzle (3 tests)	.75	.87	May and Hartshorne
13. Receiving aid in solving puzzle after having been placed on honor to receive no aid	—	—	Voelker
14. No. 13 revised. Receiving aid on test taken at home	.24	.49	May and Hartshorne
Truthfulness—Untruthfulness			
15. Overstatement in connection with books read	.74 (Ra)	.39 (T)†	Franzen, Ruch, Raubenheimer, Slaght, Terman
16. Overstatement of knowledge	.58 (C) .78 (Ra) .71 (W)	.41 (C) .48 (T)† .50-.56 (W)	Voelker, Ruch, Cady, Raubenheimer, Woodrow, Terman, Slaght

*The letter in parentheses is the abbreviation for the name of the experimenter who reported the figure.

†Median of 4 bi-serial *r*'s. Each bi-serial was determined on the basis of the degree to which the test distinguished between best one-fourth of unselected children and a delinquent group.

TABLE 1 (*continued*)

	Reliability	Validity	Experimenters using the test
17. Overstatement about one's conduct to win approval	.84	.92	May and Hartshorne
18. False statements to cover cheating	—	—	Slaght
19. No. 18 revised. False statements to cover lying to escape disapproval in several situations	—	—	May and Hartshorne
20. Self-marking	.85	—	Maller
Helpfulness—Selfishness			
21. Willingness to receive a tip for insignificant favor	—	—	Voelker
22. Degree to which the subject chooses to work for own score rather than work to help group total	.88	—	May and Hartshorne
23. Efficiency with which one works when working for individual prize as compared with efficiency when working for a group prize	.90	—	May and Hartshorne
24. Degree to which one votes to spend group money for personal profit as contrasted with expenditures for group service	.58	—	May and Hartshorne
25. Degree to which subject will respond to an appeal to share with children in need the contents of kit given him	—	—	May and Hartshorne
26. Degree to which subject will work for children in hospitals by collecting pictures, jokes, etc.	—	—	May and Hartshorne
Battery composed of Tests 22, 23, 24, 25, and 26	.80	.75	May and Hartshorne
27. Degree to which an individual will display egotism, anger, malice, diffidence, shrewdness, brutality, envy, impatience, and the like when situation requires that two or more persons work together in standardized test situations. Forty different sets of apparatus for testing of reactions of a child to other persons in the environment have been tried out	—	—	Henning

TABLE 1 (*continued*)

	Reliability	Validity	Experimenters using the test
Persistence—Lack of Persistence			
28. Persistence and faithfulness in pushing button every 2 minutes in presence of distracting material; canceling *a*'s in book containing interesting pictures; card-sorting in presence of pictures and reading material	—	—	Voelker, Slaght
29. Persistence in finishing story when the end is printed in a form which is difficult to read	.55	—	May and Hartshorne
30. Persistence as shown by choice of continuous working at one mechanical puzzle or going on to another before the first was finished	.75	—	May and Hartshorne
31. Same as No. 30 except that paper-and-pencil puzzles were used	—	—	May and Hartshorne
32. Persistence as shown by consistency of work at a monotonous task over several periods	.88	—	May and Hartshorne
Battery composed of Tests 29, 30, 31, and 32	.89	—	May and Hartshorne
33. Persistence in running a partially concealed maze which is impossible to solve	—	—	Morgan and Hull
34. Persistence in test of word-building	—	—	Chapman
35. Persistence in standing on tiptoes	—	—	Fernald
Self-Control—Impulsiveness			
36. Degree to which a subject is willing to inhibit desire to hear how a story comes out (2 stories)	.65	—	May and Hartshorne
37. Self-control in presence of temptation to begin working too early on a puzzle or a combination to a safe	.67	—	May and Hartshorne
38. Self-control in presence of temptation to play with puzzles instead of working at a rather monotonous task	—	—	May and Hartshorne
39. Inhibition of tendencies to look at drawings on a page instead of working examples which were inserted here and there	.89	—	Ruggles, May and Hartshorne
40. Self-control in presence of temptation to eat pieces of candy during a 40-minute working period	—	—	May and Hartshorne
Battery composed of Tests 36, 37, and 39	.77	—	May and Hartshorne

TABLE 1—PART 2

Batteries	Reliability	Validity
Terman-Raubenheimer battery composed of 7 tests (including Nos. 10, 15, 16, plus three tests of the knowledge type, plus Woodworth-Cady questionnaire). Population examined consisted of 532 gifted children, ages 7-14, and 533 randomly selected pupils, ages 10-14.	.75‡	.60‡
Cady battery composed of 5 tests (including Nos. 6, 10, 16, plus one test of moral judgment and the Woodworth-Cady questionnaire). Population examined consisted of 150 boys ranging in age from 12 to 14.	.75	.58
Voelker battery consisting of 10 tests (including Nos. 16, 13, 2, 1, 28, 10, 6, plus a test of accepting tips for trifling courtesy, and a test of suggestivity taken from the Downey Will-Temperament series).	.75	.60
May-Hartshorne Honesty battery (including 24 tests falling under 9 headings given above—3 tests of type No. 6; 6 tests of No. 8; 3 tests of No. 10; 3 tests of No. 12; 1 test of No. 14; 4 tests of No. 9; 3 tests of No. 11; 1 test of No. 3; and 1 test of No. 19). Sampling of unselected children in Grades 4 to 8. Number of cases upon which reliability was determined is not clear.	.72 §	—
May-Hartshorne Helpfulness battery consisting of tests Nos. 22, 23, 24, 25, and 26. Population to which tests were given was about 850 unselected children of Grades 5 to 8.	.80	.75
May-Hartshorne Self-Control (Inhibition) battery composed of tests Nos. 36, 37, and 39. The population consisted of about 850 unselected children of Grades 5 to 8.	.77	—
May-Hartshorne Persistence battery composed of tests Nos. 29, 30, 31, and 32. The population tested consisted of about 850 unselected children of Grades 5 to 8.	.89	—
Downey Will-Temperament (12 subtests with reliabilities ranging from .32 to .85).	—	—
Henning battery consisting of many different test situations in which a child must respond not only to physical objects but also to other persons in the environment. Two or more children are always tested together, and such traits as helpfulness, conscientiousness, deceptiveness, and the like are observed.	—	—

‡Estimated by Terman and Raubenheimer.
§ $r_{1\infty} = .85$.

reliability depend on the number of judges whose estimates were combined, on the extent to which the judges knew the subjects rated, and on the nature of the trait or traits upon which the rating was being done. Symonds (62, p. 353) has made a statistical estimate of the number of judges whose ratings would have to be combined to yield a reliability of .90 in each of several traits. He finds, for example, that in order to get a self-r of .90 in persistence the average would have to be made from 14 raters; in adaptability, from 16 raters; and in impulsiveness, from 18.

If the only method of increasing the accuracy of the results of rating scales were that of getting more and more raters, it is obvious that the uses of the method would be quite limited. Fortunately, however, it has been found that much improvement in accuracy of rating can be achieved by

the dividing-up of the trait or the behavior to be rated into smaller divisions and the rating of each of these separately. A good example of the effect of breaking up a rather broad trait into parts is seen in the work of Furfey (20), who found that the reliability of the judgments of adults on the "social development" of boys was only .75, but that when this general term was subdivided into eighteen components, and each of these separately rated, the reliability of the total rating rose to .90. Very recently the rating-scale method has been used with striking success by Olson (48) in the study of tendencies of children to become problem cases in home and school. The Olson-Haggerty-Wickman behavior rating scale, consisting of thirty-five items, has a reliability coefficient in a single grade range of around .86 as determined by the re-rating method, and of about .92 as determined by the split-half method.

Miscellaneous Methods

Clinical observation and questionnaire methods. An appreciable number of methods of a miscellaneous nature have been used to measure children's morals. There is, first, the clinical approach, which may consist of rating the child on the basis of an interview, or a rating based on an observation of his behavior while taking tests. Klein (39) has used the method of observing the behavior of a young child when left with dolls and pictures by which he can represent his father, mother, brothers, sisters, and other persons. The experimenter feels that certain phantasies—such as those regarding birth and sex—which may be important in later moral conduct, may be discovered. The report on morals in most case histories made by social workers is of the observational type. There is, in the second place, the questionnaire method. The most widely used device of this type is the Woodworth questionnaire on neurotic tendencies. It has been revised and made suitable for use with children by three different experimenters: Cady (9), Mathews (44), and Buford Johnson (33).

Physiological methods. Various physiological methods have been used in attempts to measure general emotionality, to determine strengths of attitudes, and to find out whether individuals were guilty of lying, stealing, etc. Olson and Jones (47*e*) have measured involuntary responses of the hands in attempts to determine how pronounced the attitudes of subjects were toward such questions as religion, race, capitalism, birth control, militarism, etc. The method, while by no means fully satisfactory, seemed to offer some promise. Experiments have been conducted with the galvanometer (by Wechsler, Brown, Marston, Landis, and others), with measures of inspiration-expiration ratio (by Benussi, Burtt, Landis, and others), and with measures of blood pressure (by Marston, Larson, Landis, Chappell, and others). Measures of reaction-time and of pulse beat have also been studied in this connection. Both Marston (43) and Larson (42) have found measures of systolic blood pressure to be a fairly good test of deception under certain conditions. But with this exception, and possibly the exception of the involuntary-hand-movement method, physiologi-

TABLE 2

TESTS OF KNOWLEDGE AND OF ATTITUDES

	Reliability	Validity	Experimenters using the test
Knowledge of Moral Standards			
1. Answers to brief questions involving moral judgments, interpretation of proverbs, definition of moral terms, and evaluation of offenses	—	—	Kohs
2. Marking of responses as right, excusable, or wrong in complex but practical situations which children face	.77	—	Jones
3. Answering questions on ethical principles	—	—	Hansen
4. Answers to numerous brief questions involving problems in morals as they are related to social, racial, economic, political, and religious issues	.92	—	Watson
5. Citizenship Scale including questions on ethical discrimination	.81-.97	—	Chassell and Upton
6. Test of information about moral acts in very simple situations	—	—	Sister Mary and others
7. Test of the ability to rank offenses in order of seriousness	.78 (R)	—	Fernald, Kohs, Raubenheimer
8. Test of foreseeing probable consequences	.91	—	Chassell, Chassell, and Chassell
9. Test of social standards in various childhood situations	.84	—	Tomlin
10. Battery of 6 tests (testing knowledge of duties, principles, cause-and-effect relations, social-ethical vocabulary, good citizenship, and classification of offenses)	—	—	May and Hartshorne
Attitudes			
11. Degree of intimacy with various races which subject thinks is correct one for him	—	—	Bogardus
12. General racial attitudes as shown by answers to questions concerning economic, political, social, and intellectual status of other races	.82	—	Watson
13. Citizenship Scale including questions on racial attitudes	—	—	Upton and Chassell

TABLE 2 (*continued*)

	Reliability	Validity	Experimenters using the test
14. Attitudes toward various social conventions and organizations	—	—	Hart
15. Attitudes and interests as shown by reading preferences tested by ranking of book titles	.80	.47*	Raubenheimer, used by Terman
16. Attitudes and interests in selection of friends as shown by preferences for characters described in brief character sketches	.79	.27*	Raubenheimer, used by Terman
17. Attitudes toward organizations, professions, activities, etc., as shown by answers to questions	.77	.63*	Raubenheimer, used by Terman
18. Activity preferences as shown by a series of choices among suggested activities	.74	.50*	Raubenheimer
19. Battery of 9 parts designed to measure general attitudes and opinions toward a variety of life situations	—	—	May and Hartshorne
20. Scales for the measurement of social attitudes (attitudes toward war, Negro, church, etc.)	—†	—	Thurstone
21. Self-ordinary-ideal rating	—	—	Sweet
22. Character sketches showing personal attitude and personal evaluation of self	.95	—	Maller

*Bi-serial *r*.
†Different for different scales.

cal measurements have not proved to offer even reasonably satisfactory reliability for the testing of any important aspects of moral behavior.

An entirely different line of approach is that illustrated by Lindemann (42*c*) who shows that one who is under the influence of certain drugs like sodium amytal, for example, finds it very difficult or impossible to inhibit ideas and to deceive, but research along this line has not progressed far enough to justify any definite statement as to how this method may be used to test moral behavior.

Facial expression. Facial expressions as indicators of morality have received some attention. There is a very deeply rooted popular belief among many that lying can be detected by the evasive eye and stealing by a sheepish look. But the studies of facial types and expressions give little support to such a belief. Lombroso attempted to identify certain criminal types, but a crushing blow was struck to this work by Goring (21), who made a careful investigation of three thousand convicts in England. He concluded, as a result of his long statistical study, that "there is no such thing as a criminal class, differentiated by anomalies of physique." His photographic profiles show clearly that a theory of facial types among first offenders at the time of their commitment has little ground to stand on.[3] The study of the play of expressions of an individual during the experiencing of various emotions would seem to offer greater promise than the study of set characteristics. However, two separate studies, that by Feleky (14) and that by Langfeld (41), have shown that expressions of hate and of suspicion, as shown in photographs, cannot be correctly identified, but are confused with the facial expressions shown in fear, anger, surprise, and the like. Sherman's (56) work shows that the interpretations of the expressive reactions of infants were not reliable. Though there are no conclusive studies on the central problem of the degree to which honesty, truthfulness, and the like can be identified by facial expressions, such studies as these are close enough to the problem to justify one in inferring that popular belief places far too much confidence in judgments based on facial expressions. There is no doubt that the countenances of some offenders do give them away in certain situations. Also, there is no doubt that some judges are more accurate than others in their estimates of morality from a study of the expressions and other reactions of an individual in an interview. But, on the average, judgments concerning the morality of children from a study of their expressions are too unreliable to be of any practical value.

Serious Violations of Social Standards as Tests of Morality. When such tests as those listed in Tables 1 and 2 are given to a large number of children, we find that there are all degrees of violations in almost all traits. However, in such social institutions as the court, the church, the school, and the home, certain minimum standards are set up, and one who falls

[3]The problem of whether or not there is a change in a man's facial expression in the direction of a convict type during a long period of confinement in a penitentiary is a separate problem from the one discussed above.

TABLE 3

OFFENSES AND FREQUENCIES OF OCCURRENCE AMONG CHILDREN SENT TO CHILD GUIDANCE CLINICS

(Frequencies in percentages)

Offenses	Philadelphia clinic (163 cases)	Los Angeles clinic (167 cases)	Total (330 cases)
Stealing	38.7	36.5	37.6
Lying	37.4	28.7	33.1
Truancy	28.2	21.6	24.9
Disobedience	19.7	21.6	20.6
Running away	16.0	17.9	17.0
Bullying	16.0		16.0
Fighting	12.9	7.8	10.4
Offenses of sex nature	9.8	23.4	16.6
Non-moral offenses, including temper tantrums and enuresis	35.5	26.4	31.0

below these standards is looked upon as a serious violator by those who agree with the standards. The standards set up by the court are usually agreed to by the vast majority of people, and therefore violations of the laws of the land are considered as tests of serious misconduct. Though it is obvious that there is opportunity for some fine distinctions at this point, for our purposes here we shall define a serious violator as one whose acts are considered serious enough to lead to his being taken to court or being referred to a psychiatric clinic for study. Taking this criterion, it is possible to determine what the serious violations are and with what relative frequency they appear. Blanchard (6) presents figures concerning the conduct disorders for which 330 children were referred to a guidance clinic by court, school, and home. The cases are taken from two different child guidance clinics, 163 of them being from a clinic in Philadelphia and 167 from a clinic in Los Angeles. All of the children were in Grades 3-9. Table 3 gives the offenses and the percentage of children committing each offense. Of course, in many cases more than one complaint was registered against a child, consequently the total of the percentage frequencies exceeds 100.

If we set as our criterion of seriousness that for which young people are given sentences by the juvenile courts, we get another list of offenses, which does not differ very greatly from that given in Table 3. Stealing again heads the list for boys, with truancy, running away, lying, and sex offenses following in the order named. With girl delinquents, sex offenses head the list, with stealing, running away from home, lying, and truancy following in order. These facts are based on Healy and Bronner's (29) statistical analysis of four thousand juvenile delinquents of Boston and Chicago. The offenses occurring with greatest frequency have been culled out and are presented in Table 4.

TABLE 4

OFFENSES AND FREQUENCIES OF OCCURRENCE AMONG FOUR THOUSAND JUVENILE DELINQUENTS

(Boys and girls separate. Frequencies in percentages.)

	Boys			Girls		
Offenses	Chicago (1386 cases)	Boston (1444 cases)	Total (2830 cases)	Chicago (614 cases)	Boston (556 cases)	Total (1170 cases)
Stealing, not including burglary and hold-ups	68	73	70.5	31	41	36
Truancy	38	42	40	6	2	4
Running away from home	44	36	40	31	36	33.5
Excessive lying	11	9	10	21	15	18
Offenses of sex nature	9	10	9.5	69	55	62
Major breaking and entering	13	4	8.5			
Gambling	2	4	3			
Intoxication	3	2	2.5	3		1.5
Robbery (hold-ups)	3		1.5			

NATURE'S CONTRIBUTION TO INDIVIDUAL DIFFERENCES IN MORALITY

Having considered the individual differences which exist in moral behavior, we are immediately faced with the problem of the causes of these differences. Does a child show up poorly in moral behavior because he was born "short" in those factors which make for morality, or because the education which his environment has afforded has been faulty? This raises the age-old controversy of nature and nurture, and it raises it in a most complex field of behavior. If one were starting out, at the present stage of knowledge, to arrive at any percentage contribution of each of these two great forces in accounting for individual differences in morals, he would be doomed to failure. There is such a multitude of unmeasureable variables subsumed under each of the concepts of nature and nurture, and they interact in such intricate ways, that the crucial experiment to determine the exact relative influence of each is at present out of the question. However, sufficient analyses have been made to indicate that innate differences in such factors as intelligence, age, sex, race, instinctive tendencies, and possibly certain emotional and volitional factors, are related to differences in moral behavior. A brief discussion of the relation of some of these factors to individual diffierences in moral behavior will be given.

Influence of Intelligence. The statistical facts which are available on the relation between intelligence and moral behavior can be summarized under three headings: first, the comparison between intellectually gifted children and unselected children on tests of moral behavior; second, the correlation between general intelligence and scores on tests of morals; and third, the intelligence of serious offenders or delinquents. Terman (65) compared a group of 532 children having IQ's over 130 with a group of 533 unselected children by means of a battery of seven tests of moral ability. He found that 85 per cent of the gifted group equaled

or exceeded the mean of the unselected group. The results for each age group are given graphically in Figure 4. Terman also had teachers rate the children of the gifted and the control groups on twenty-five traits. If we select out of his list those traits most closely related to the problem of morals, and compare the ratings assigned to the two groups, we find that 73 per cent of the gifted boys and 74 per cent of the gifted girls exceeded the respective means of the control groups. The five traits upon which the above figures are based are conscientiousness, truthfulness, sympathy and tenderness, will and perseverance, and prudence and forethought. The gifted group exceeded the control in every trait, the greatest difference being in "will and perseverance," where 84.5 per cent of the gifted exceed the mean of the unselected, and the least difference being in "sympathy and tenderness," where only 58.5 per cent of the gifted exceed the mean of the others. Terman concludes from his experiment that intellectually gifted children "surpass unselected children in tests of honesty, truthfulness, and similar moral traits." As he clearly points out, the gifted are

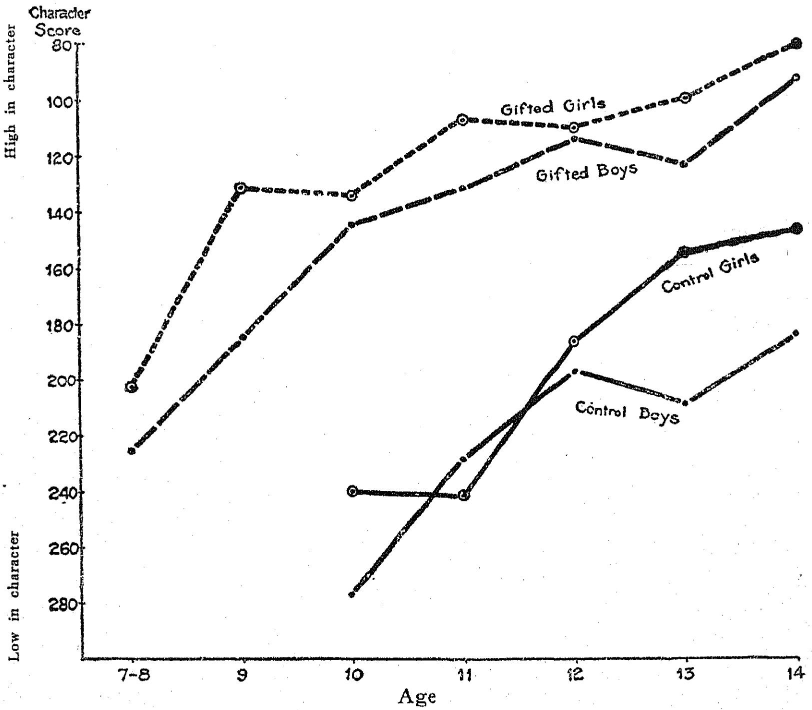

FIGURE 4

MEAN TOTAL SCORES OF GIFTED AND CONTROL CHILDREN, BY AGE, ON SEVEN CHARACTER TESTS

(From L. M. Terman's *Genetic Studies of Genius,* Vol. 1. Stanford University, Calif.: Stanford Univ. Press, 1925, p. 515.)

not free from moral faults, at least one out of five having even more than the average of the general population; however, the difference between the two groups, on the average, is certainly striking.

The most significant study of this problem by means of the correlation technique is that of Hartshorne and May (25). These experimenters, using a wide battery of tests and measuring a large number of elementary-school children, get as their final result a correlation of +.50 between intelligence and amount of honesty in school situations. They attempted to measure the home background of the children, and to partial out this factor by using the partial correlation technique. The partial r between intelligence and honesty with home background constant was found to be +.397. If this were reliable, it would mean that, if we took a group of children of exactly the same home background, we should get a correlation of about .397 between intelligence and honesty. This is perhaps too high, since it is doubtful if the rating scales of home background used by Hartshorne and May adequately measured parental care and guidance. However, even if we should discard the partial as being impossible to interpret, due to the overlapping of uncontrolled factors, nevertheless the straight r of .50 certainly means that there is an appreciable tendency for pupils who stand high in intelligence tests to stand high also in honesty as here measured. The same experimenters (26) also correlated scores in intelligence with objective measures of helpfulness and persistence. The correlations were .16 and .18, respectively.

The wide range of correlations from .16 in helpfulness to .50 in honesty probably means that intelligence is related in different ways to different behavior situations. As will be shown later under the discussion of the specific nature of moral behavior, the same "morality" is not being measured by all these tests, but rather different phases of moral behavior are being measured in different ones, and there is no reason to expect the relation of intelligence to be the same in situations included under helpfulness as it is in the situations included under honesty. However, we are primarily concerned at present as to whether or not the relation is consistently positive. The correlation studies conducted so far are practically unanimous in indicating that high scores in intelligence are to some extent accompanied by high scores in the various tests of moral behavior.

The studies on the relation of intelligence to delinquency have concerned themselves very largely with the question of the amount of feeblemindedness in delinquent populations. Burt (8, p. 286) has made a very thorough study of delinquents in England and concludes that 8 per cent of the cases coming before him have been feebleminded, that is, below 70 IQ. Healy and Bronner (29), working in the United States, report that 13.5 per cent[4] of the four thousand delinquents examined by them in Chicago and Boston were feebleminded. These two figures should be compared with

[4]This figure is taken from Healy and Bronner's latest and most extensive study. In the different investigations conducted by Healy in different cities he has obtained slightly different percentages, as would be expected.

the figure 2 per cent, which is the amount of feeblemindedness in the general population. Following these two reports, which give the most conservative figures that have been reported on juveniles, we may conclude that from 4 to 7 times as much feeblemindedness exists in delinquent groups as in the general population. However, after all, the 8 per cent or the 13.5 per cent is a relatively small part of the total, and the question may be raised as to the intellectual status of the remainder. Following Burt's distribution, we find that 66.5 per cent of the delinquent group have IQ's of 95 or below, while only 8.1 per cent have IQ's above 105. If there were no more dullness among the delinquent group than among unselected children, we should expect to find IQ's distributed in a manner similar to that found by Terman (64) in his study of 905 unselected children. But in Terman's group we find 31.3 per cent, instead of 66.5 per cent, below an IQ of 95, and 34.9 per cent, instead of 8.1 per cent, exceeding 105. Healy and Bronner do not give detailed frequencies by which it is convenient to get similar data, but the average of the distribution of IQ's is 90,[5] agreeing within one point with that of Burt, and being decidedly below the average of the general population. These figures show that there is a greater percentage of dull and dull normals among delinquents than in the general population. This, then, is the third line of evidence pointing to the conclusion that intelligence is somehow related to moral behavior.

Any statement to the effect that there is a causal relation existing between intelligence and morality has been carefully avoided, because it is very clear that all of the three lines of evidence just given could be true and still mean only that those factors which ordinarily go with good intelligence also go with high scores in moral behavior, and that intelligence is not accounting for morality any more than morality accounts for intelligence. Nevertheless, the relation is interesting in a common-sense way, if we are not too much bent on arguing back to lines of causation. The first obvious conclusion is that dull and dull-normal children will, on the average, be more likely to be brought before juvenile courts for serious violations of moral standards than bright children, if everything else, including the environment, is left alone to work itself out as it will. The second is that, although the gift of good intelligence does not guarantee adequate moral responses, such a gift, plus all the other advantages and opportunities which usually go with it, does give one a better chance to acquire high moral behavior.

Influence of Age. The relation of chronological age to moral behavior is clearly tied up with the relation of intelligence to moral behavior. It is also intricately connected with the influence of environment upon

[5]The average for unselected children is 100. However, there is a possibility that, since 44 per cent of Healy's group was over fourteen years of age at the time of the test, the intelligence quotients of this portion of the group are slightly too low. Liberal correction for any such error due to the norm's being too high would not, according to my estimate, raise the average above 93.

morality. As Jones (34) has shown in a study of the influence of age and experience on tests of intelligence, the mere fact of a longer period of living in the world gives the older child certain advantages over a younger child of the same mental age. It is not unlikely that there is a similar relation between maturation and moral behavior which will not be fully explained by all the other relations which will be discussed.[6] However, the interrelations are too complex to justify any attempt to measure any *unique* contribution which age makes to moral behavior. All that will be attempted is to summarize the facts available on such questions as whether older children cheat and lie more than younger ones, or whether persistence and helpfulness increase with age. Slaght (58) compared older and younger boys on their ideas as to whether it was wrong to "cheat if you can," "lie to keep a secret," and "lie to get even with someone," and found that a far greater percentage of the younger children than of the older reported each of these as wrong. Tudor-Hart and Bühler (72) found that the considering of lying for a social motive as defensible increases steadily with age from seven to twelve. Hartshorne and May (25) do not find any evidence to indicate that cheating in school decreases as children grow older, nor do they find any reason for believing that children in our public schools become less selfish as they grow older. In Terman's (65) study of 532 gifted and 533 unselected children there is a clearly defined tendency for total "morality" scores, as determined from an average of seven tests, to increase with age. This is shown graphically in Figure 4, page 498. But it is interesting to note, upon study of the separate distributions for the various tests, that the older children get their advantage very largely from tests in which knowledge of the most acceptable answer counts most. The older get the major part of their advantage on the following tests: reading preferences, character preferences from written descriptions, social attitudes, and the Woodworth-Cady questionnaire on emotional instability. On the tests of the degree to which subjects overstate with respect to books read and knowledge possessed, there is no perceptible increase in honesty with age either in the gifted or the control group. On the "peeping" test there is no consistent tendency for the older gifted children to be more trustworthy than the younger.

All these negative results make a rather discouraging picture when it is considered that the oldest children have had the training of home and school for seven or eight years more than the youngest. There are three other relations which should be mentioned, though it is by no means certain in every case that these can be interpreted as making the picture more optimistic. The first is that children seem to become slightly more persistent with age, the correlation between scores in persistence and age having been found by Hartshorne and May (26) to be +.33. The

[6]This is due to the inadequacy of our present-day tests in measuring all the increasing potentialities for profiting by experience attending maturation.

second is that children, as they grow older, learn better what the accepted standards of adults are, both those which are practiced and those which are preached. Third, with changes in age go changes in the manifestations of misconduct. The types of stealing, for example, which children at various ages engage in vary directly with the amount of experience and foresight possessed.

This summarizes the findings on the relation of age to moral behavior for children ranging in age from seven to fourteen. It is to be regretted that sufficient facts are not available for young people above fourteen to justify us in any conclusion as to what relations may exist during or after the adolescent period. We do know from Healy and Bronner's (29) work that first offenses serious enough to warrant arrest steadily increase with children from age eight to age sixteen inclusive, with the most rapid rise for boys being between ages thirteen and fourteen, and that for girls between ages fourteen and fifteen. However, we are not sure whether these rising figures mean a continuous deterioration in moral behavior from age eight through the adolescent period or whether they simply mean that older children have better opportunity than the younger ones to commit offenses of a nature that will lead to arrest.

Influence of Sex. There are appreciable differences found here and there between the moral behavior of boys and girls. These differences exist, however, in connection with certain specific types of behavior. Since it is impossible at present to get any measure of all-round morality comparable to measures of general intelligence, no one can say whether or not girls and boys are as closely similar to each other in general morality as in general intelligence. Tudor-Hart and Bühler (72) asked a large number of children in Austria and in America to name any cases which they could think of where lies were necessary. They found, in comparing the answers of boys and girls, that the girls gave a much larger number of conventional lies—such as "Mother is not at home," "Glad to see you," or "I've had a fine time at your party." An appreciable difference was found in all lies which might be grouped under the heading of social, including lies to keep secrets, to conceal surprises, to protect others, to keep from offending, and the like. Thirty-two per cent of all the lies named by the girls, as compared with 18 per cent of those by the boys, were of this type. Hartshorne and May (25) found that on the basis of general averages there was little difference between the sexes in honesty, but the girls cheated more on the party test, where cheating consisted of peeping in order to make a good score in games at the party, and on a home-work test, where aid was obtained dishonestly at home. Terman (65) found, on the basis of a peeping test, that gifted girls were a little inferior to gifted boys; however, when these results are combined with the results of two overstatement tests and tests in which ability to give socially acceptable answers to questions is heavily weighted, the totals place the girls slightly above the boys in honesty. Figure 4 (page 498), which has already been mentioned in another connection, shows the differences be-

tween boys and girls at each age level. Olson (48) found by means of his behavior rating scale that boys have more tendencies toward conduct difficulties than girls, and the difference between the two groups was statistically reliable.

From such scattering items of fact it is perhaps hazardous to attempt any generalization, but these findings of Terman and Olson, plus the commonly accepted fact that there are more boy delinquents than girl delinquents, do make it appear that more boys than girls fail to meet the minimum standards of moral conduct. Of course, even if this is true, it does not necessarily follow that the distribution of moral achievement of boys is throughout the range lower than that of girls. It is possible, though no facts are available to prove or disprove it, that there is greater aggressiveness toward superior moral behavior among boys at the upper end of their distribution than among girls at the upper end of theirs. If this were true, the greatest creativeness in moral behavior would come from the boys.

When a study is made of the types of offenses for which boys and girls are brought before juvenile courts, great differences are found. It has already been shown in Table 4, page 497, that the most frequent offense among delinquent girls is one of a sexual nature, 62 per cent of the girl delinquents facing this charge. A distant second among the girls is stealing, which is the charge in 36 per cent of the cases. With the boys, stealing tops the list and accounts for 70.5 per cent of the charges, while sex offenses are mentioned in only 9.5 per cent of the cases. Of course, the facts concerning sex differences obtained from the study of juvenile court cases cannot be interpreted apart from the differences in moral standards set for boys and girls. Some may say that the greater percentage of sex offenses charged against the girls does not represent so much a difference in moral behavior as it does a "double standard" of judging the "morality" of boys and girls. However, these facts are very relevant to the question of sex differences if we think of these as differences in adequacy of response to situations where the adequacy of response is judged in terms of existing standards of home and court.

Influence of Race and Nationality. Figures on the relation of differences in racial and national groups to moral behavior are rather meager. Those which are available are subject to two major faults. First, the language factor is often not controlled, and, secondly, the factor of selection is not allowed for. Before we can conclude anything about true racial or national characteristics from differences found between two racial or national groups, we must be sure in the first place that this difference is not due to the language factor in the test or in the administering of the test; and, in the second, we must be sure that the sampling taken of the race or nation is really representative of a random sampling of that race or nation in its home land. One set of facts which is available on racial differences is that of Hartshorne and May (25, p. 171) on tests administered in English to children of various racial and national

groups in the United States. It seems probable that the influence of language was a small factor in the results from the cheating tests given; therefore the results will be presented for only this one function. The experimenters give not only the percentage of cheating in each racial group, but, in order to make some allowance for differences in intelligence in the group, they also calculate the amount of cheating done by each group over what would be expected in view of its average intelligence. These figures were worked out separately in two different school populations, except in the case of the Slavs and the Negroes. The present writer has combined the two sets of results—which are rather similar—into one score and has ranked these scores. The final results, together with the number of children tested in each group, are as follows: children of Scandinavian-Germanic descent cheat least and therefore take first place ($N = 163$), the Americans come second ($N = 363$), the inhabitants from the British Isles third ($N = 100$), the Jews fourth ($N = 246$), the Italians fifth ($N = 97$), Slavs sixth ($N = 31$), and Negroes seventh ($N = 100$). These figures are based on relatively small numbers and would be of rather doubtful significance if it were not for the fact that Healy and Bronner's (29, p. 107) results in the case of serious offenses agree so closely with them. They have calculated the number of delinquents in each racial group in relation to the number of people of that race or nationality in the country. Considering the American group's quota of delinquents as the standard, the children of Germanic and Scandinavian origin had about one-half their proportional number, the British and Canadians very slightly above their quota, the Slavs about one and one-half times theirs, the Italians nearly twice theirs, and the Negroes twice theirs. Facts for the Jewish group are not given.

How great a part environment plays in accounting for these differences it is impossible to say. It is known that members of racial and national groups tend to congregate in their own communities in the larger towns and cities. It is likely that the children in such communities develop habits and attitudes which bear the marks of the life which they find about them. However, the controversy which the environmentalists and hereditarians might raise as to *why* the Italian children and the Germanic-Scandinavian children in this country show different moral behavior should not blind us to the very important fact that they do show differences.

Influence of Changed Bodily Conditions Resulting from Disease.[7] Mental diseases such as schizophrenia and the more purely physical diseases like meningitis or syphilis (which may definitely affect the neurological structure) often yield changes in the moral behavior of their victims. The one disease which has attracted most attention along this line in recent years is encephalitis. Many European writers particularly, including Agostini (1*c*), Allers (1*e*), Levi (42*a*), Nathan (47*c*), Schachter (53*a*), Stertz (61*a*), Ventra (72*b*), and others, have cited cases showing rather

[7]The writer is indebted to Dr. R. R. Willoughby of Clark University for suggestions concerning this topic.

abrupt changes in moral behavior following this disease. Sometimes the change in the behavior occurs soon after the onset of the disease; sometimes it appears in a serious form as late as seven or eight years after. The chief offenses noted are disobedience, lying, stealing, sex offenses, and violence, and these occur in the case of individuals who were, presumably, well adjusted previous to the contraction of the disease.

Such changes in moral behavior attending disease present an interesting theoretical problem. If we knew the mechanisms by which satisfactory moral behavior was rather suddenly replaced by a definitely unsatisfactory behavior, then perhaps we would have a better idea as to just what happens in the organism in the development of morality. But unfortunately the studies shed little light on this. They are all, with only two or three exceptions, concerned with the presenting of the facts as to the change in behavior. The most promising hint which the writer gets is that disease may so affect neurological structures as somehow to throw out of equilibrium, so to speak, the integrations which the individual has achieved. Some evidence for this view is presented by Bond and Appel (7*a*), who state that they find in the post-encephalitic condition not only lying and stealing but heightened feelings of insecurity, stronger regressive tendencies, and more intense introversion or extroversion. If these observers are correct in stating that these are signs of increased inner conflict in this condition, then we would expect that the integration in behavior which had been achieved up to this time would be unsatisfactory and that changes would appear. We would also expect that remnants of old integrations might remain and that the victim would alternate, as he usually does, between the new types of behavior and remorse for having forsaken the old.

Inheritance of Moral Sense and Moral Traits. In any discussion of the native factors connected with moral behavior, the old question arises as to whether or not a moral sense or moral traits can be inherited. The intuitionists[8] of the seventeenth and eighteenth centuries argued for an intuitive faculty which could perceive without training what was moral and what was not. The special application of this concept to the study and treatment of young delinquents was made by Maudsley (45) in 1872. His doctrine was that deficiency in "the common power of forming moral intuitions" existed in many, and perhaps most, young criminals. Among very recent writers this view in its full form has been represented best perhaps by Tredgold (71, p. 326), who describes the morally deficient as those who are "fundamentally lacking in moral sense."

Few psychologists today hold to the view of the inheritance of moral traits. It is true that two important recent studies have shown a notable similarity in the moral behavior of siblings and of twins. May and Hartshorne (46) have found higher correlations in deception among siblings reared in orphanages than would have been expected from correlations among children paired at random. Lange (40*a*) presents some

[8]See, for example, Lord Shaftesbury (54, Vol. 1, pp. 124-125).

striking facts on criminality among twins. He found representatives of thirty pairs of twins in institutions for criminals; thirteen of these pairs were monozygotic and seventeen were dizygotic. In the case of the monozygotic twins both members had been sentenced in ten out of the thirteen pairs. In the case of the seventeen dizygotic pairs there were only two cases in which both members of the pair had been sentenced. The interpretation of these findings, as they bear on the inheritance of a moral sense or of moral traits, is made difficult by the fact that intelligence and early conditioning factors which may have definitely influenced the dynamics of conduct have not been held rigidly constant. There is a difference between saying that inheritance affects the sub-structure upon which moral behavior is usually built and saying that inheritance affects the moral conduct directly. By studying averages we would be unable to tell which was the proper explanation, for probably we would come out with the same figure in either case, but the difference in the theory is important. The writer's view is that children do not inherit their moral standards or their specific moral conduct in this situation and that; they inherit both the capacities for responding to stimuli and certain patterns of response which form the cores upon which satisfactions and annoyances are built. They acquire their morality through responding to the situations which the environment affords.

The Influence of Nurture

The repertoire of moral reactions which a child is able to make is dependent upon his nature, but *what* reactions he makes within the range of his potentialities are dependent upon his environment. This accounts for the fact that what is moral differs from age to age and from country to country, but man's desire and ability to make moral reactions has been present in every land from the dawn of history until now. Confining our discussion to the present, the most potent environmental factors in influencing children's moral reactions may be discussed under the following headings: home influences, associates, Sunday schools, day schools, and recreational activities, including club membership, moving-picture attendance, and reading.

Influence of Home. The most important place in a list of environmental factors influencing moral behavior must be assigned to the home. Children from their earliest age look first of all to their parents for guidance by precept and example. Paynter and Blanchard (49), in their analysis of the factors underlying the conduct disorders of the 330 children brought before their clinics, place the factor of poor training and discipline first, and assign this as an important factor in 90 per cent of the cases. The third place in their list is given to broken homes, and this is assigned as a contributing factor in 40 per cent of the cases. Fernald (17), in a study of delinquent girls, finds that 87 per cent came from broken homes or homes where the example given to the children was definitely inferior. Hartshorne and May (24, 27) correlated children's ideas of right and wrong with the ideas of each of the following: parents, friends, club

leaders, day-school teachers, and Sunday-school teachers. They found the correlation between child and parent to be the highest, with r equaling .545, and that between child and Sunday-school teacher to be the least, r equaling .002. Within the home it was found by the last-named experimenters that there is a closer relation between the ideas of child and mother than between those of child and father. The influence of the size of family on the moral behavior of children has received some attention from experimenters, but no general conclusions can be drawn. If a child gets the impression that he is not wanted by his parents, or if the presence of a younger brother or sister is interpreted as detracting from the love and attention which he was receiving, he has greater difficulties in making satisfactory personality adjustments, but whether the adjustments finally made will lead to better or poorer moral reactions remains an open question.

The economic situation in a home is an important factor to be considered in cases where it is very poor. However, it seems to be the general level of parental supervision and general level of associates with whom children are thrown rather than periodic changes in family income which exert the main influence on moral behavior of youth. Jones (38*a*) has shown in the case of the state of Massachusetts that juvenile delinquency did not rise even during the big swing of the economic pendulum which took place in the years 1929 to 1932. Theft and other crimes against property did rise noticeably with adults, but apparently the shock of economic strain and stress affects the children much less or its influence gets under way much later. If, however, due to insufficient earning power over long periods of time, both parents have to be away from home, or if boarders and roomers have to be taken in, or if the family is forced to live in bad sections of cities or towns, then the children are placed at a grave disadvantage. There is no evidence to indicate what effect increases in wealth of the family above the average may have upon the moral development of children. It seems probable, however, that in the range between the moderately comfortable home and the luxurious one it is the examples of a child's parents and his associates, hereditary factors being equal, which make the greatest difference in the moral behavior of children.

Influence of Associates. In the period of history previous to the development of wholesale machine production and the rapid growth of cities, a great percentage of a child's activities was confined to the home. At that time a child's moral behavior was learned pretty largely in the home circle. But with the passing of the household production system has come more free time for children, and with the growth of cities has come greater and greater opportunities for association with those outside the family. Today the influence exerted upon a child's moral behavior by the behavior of his associates is second in importance only to that of the home, and in the case of many children it is the stronger force.[9] Healy (28, p. 293)

[9]Of course, the influences of the two are not unrelated because the neighborhood in which a child's home is located is often the neighborhood from which he selects his associates. At present it is impossible to disentangle the interrelations existing among the various influences.

concludes from his study of delinquents that companions play an immense part in affecting moral behavior. Hartshorne and May (24, 27) find in the case of a large number of school children that the correlation between a child and a friend in knowledge of right and wrong is .353, which is surpassed by only one correlation computed and that was the one between child and parent. Furthermore, they find that the correlation between a child's standing on tests of deception and that of a friend not in the same classroom is .23, whereas the correlation between a child and his friend in the same classroom is .66. These results are typical, and lead to the general conclusion that the effect exerted by one's companions is greatest when they are present and in position to influence his behavior through suggestion, the passing of judgment, and the like.

This leads to the mention of the influence of group morale. In the case of gangs the standard of behavior accepted in the gang molds the behavior of any newcomers. In a school or school class the situation is different from this only in degree. If a class group remains fairly well intact for several years, certain habits and attitudes toward neatness, cheating, courtesy to teacher, and the like are gradually developed. These habits and attitudes of the group are, of course, very specific. A group may, for example, develop a sort of tabu concerning cheating, but may look with favor rather than disfavor on disrespectful treatment of one's fellow in the form of snobbishness. Concrete evidence on this point is supplied by Hartshorne, May, and Shuttleworth (27). They give figures based on elaborate testing of moral knowledge and conduct to show that "experience within a classroom tends to build group morale with the passage of the classroom groups through the grades" and that this morale makes for greater homogeneity in the conduct of the members of the group.

Influence of Church Instruction. Historically the problem of morals has been intimately associated with religion, and no discussion of children's morals would be complete without at least a recognition of the question of this relationship. Recently a theoretical treatment of the value of the religious "drive" in moral behavior has been presented eloquently by Sockman (59). Such a presentation of the case for religion in moral growth is very valuable for defining problems and clarifying issues in the realm of belief. The crucial problems raised by such a treatment are a challenge to thought. However, since it has not been possible or feasible up to the present time to submit the more important of these problems to experimental study, it will be necessary in this chapter to refrain from venturing any opinion concerning some of these larger questions of the relation of religion to morals.

A few studies, however, have been conducted in which comparisons have been made between church-school attendance and moral behavior as measured by tests of honesty and cooperativeness and between knowledge of the Bible and character ratings. Hartshorne and May (25), working with large numbers of children in public schools, compared the amount of cheating done in a Sunday-school-attending group and in a non-Sunday-school-

attending group. In their first large sampling the percentage of cheating in the Sunday-school group was 31 as against 40 in the non-Sunday-school group. In their second sampling the percentages were respectively 38 and 43. The same experimenters (26), working with another group of 84 children, found that those who attended church schools obtained somewhat higher scores on tests of helpfulness than those who did not, and those who were regular in attendance did better than those who were irregular. Maller (42*d*) found on the basis of objective tests that the honesty of a group of Jewish children appreciably increased by attendance at religious schools.

All these differences are rather small, but they are found consistently. It may be argued by some that the differences noted in favor of the church-school group are due not to church-school attendance but to factors in the heredity and homes of children whose parents are sufficiently concerned about their welfare to send them to such schools. As has been said before, the accuracy of such guessing as to the interrelations among factors cannot be proved or disproved due to the impossibility of measuring and controlling all related variables. But the fact remains that in these studies the children who attended church schools did better by a small extent on the tests than those who did not attend.

With regard to the influence of biblical knowledge on the moral conduct of children, it is impossible to draw any conclusions at present. Taylor and Powers (63), working with school children, correlated the results on the Laycock Bible Test with character ratings based on the combined judgments of two teachers and found a correlation of $.50 \pm .06$, whereas the correlation between the character ratings and intelligence was only $.24 \pm .08$. On the surface of it this seems to mean that children who knew many biblical facts impressed their teachers more favorably than those who knew few, and that this difference could not be fully accounted for by the influence of intelligence.[10] However, Hightower (32*a*) made a study of the same problem and found little or no relationship between biblical knowledge and the different phases of moral behavior tested. He compared biblical knowledge scores with teachers' ratings of character and with test results in cheating, lying, unselfishness, etc. The differences in the results of these two studies tend to confirm the suspicion that there are many factors here besides biblical knowledge and conduct. Until the effect of intelligence on various aspects of moral conduct is known, the relationship between knowledge of the Bible and home influence is allowed for, and the other effects of church-school attendance besides growth in biblical knowledge are rendered constant, we cannot hope to draw any conclusions about the relation of such knowledge to moral behavior.

Influence of Regular Day Schools. There is no evidence to indicate that improvement in the moral behavior of children as they progress through

[10]Assuming the correlation between the Laycock Test and the test of general intelligence to be .70, the partial r between knowledge of the Bible and character with intelligence constant would be .48.

the grades is at all general. There is improvement in spots, but there also seems to be retrogression in spots. The improvement on the part of a child seems to be contingent not upon mere attendance at school but on very specific experiences in his relation with his teacher and with his class or school group. The mere fact of being in a room where the class spirit is of a certain kind has been found to be an important factor in cheating. This has already been discussed under the influence of morale among associates, where it was shown that in a trait like cheating a child is much more like a friend of his in the same classroom than a friend in a different classroom. The influence of the teacher on the amount of cheating has also been studied. It has been found, for example, by Hartshorne and May (25) that one section of a fifth grade under one teacher cheated only one-half as much at the end of a year as it did at the beginning, whereas the other section of the same grade under another teacher in the same school cheated more at the end than at the beginning. Time after time these experimenters found big differences in the honesty scores obtained by different classes in the same school building. It is impossible to say how much contribution the pupil-teacher relation makes to these differences among classes and how much the pupil-class relation makes, but if we consider these two together we have the two factors in the school situation which are most clearly related to changes in moral behavior.

Influence of Recreational Activities. It is popularly believed that the leisure-time activities of children are related in significant ways to growth and retrogression in moral behavior. Unfortunately, however, very few experimental facts are available concerning this relation. Practically no work has been done with any recreational activities besides club activities, moving-picture attendance, and story reading, and consequently this discussion will have to be confined to these three.

Club membership. The pioneer objective study of morals was made to determine the influence of the Boy Scout work on trustworthiness. The experiment was conducted by Voelker (73). He worked with 57 boys, ranging in age from ten to fourteen. At the beginning of the experiment he gave the series of tests which was described on page 490. Then, during the experimental period of seven weeks, two groups of about ten boys each were given intensive Boy Scout work on trustworthiness, which consisted of the learning of codes, discussions, exhortations, and actual practice of honesty wherever possible. There was, in other words, a very definite attempt made to build up the ideal of honesty. In two other groups consisting of about the same number of boys and having about the same scores on the initial test, regular scout training was given, but less work deliberately designed to emphasize honesty was included. The remaining boys were in two groups which received no scout training and no training in trustworthiness. At the end of the experimental period all of the six groups were retested with a test similar to that used at the beginning. It was found that most progress had been made by the two Boy Scout groups receiving the intensive training, and that the least progress was made by the two groups which received no scout training. Though the results

are based on too few cases to justify an unqualified conclusion, they strongly suggest that Boy Scout training helped in the development of trustworthiness, especially when the training was specially directed toward that end. Hartshorne and May (25, 26) conclude from their comparison of the scores made on their tests by children who were members of clubs and those who were not, that club members, no matter what the organization, are more cooperative than non-members, but that club members do not consistently exceed non-members in resisting temptation to cheat in school tasks.

The general conclusion seems to be that club membership will aid children in their moral development just in so far as the activities in that specific club provide opportunity for the children to do with satisfaction desirable acts and make proper generalization from these acts.

Moving-picture attendance. Much concern is shown by all those interested in children's morals in the influence of moving-picture attendance, which is undoubtedly a favorite recreational activity. Of five hundred children examined in a school district of Toledo, Ohio, 58 per cent were found to attend moving-picture shows on Saturday or Sunday of each week. In this city there were only 5 per cent who did not attend rather regularly; in Providence, Rhode Island, the corresponding figure was 6 per cent. The average frequency of attendance for the group in Toledo was twice per week. The average frequency of attendance of high-school children in Omaha, Nebraska, is reported by Sullenger (61*b*) to be once per week.

Healy and Bronner (29) in America and Burt (8) in England have studied the influence of moving pictures on delinquency. The former conclude from their study of four thousand cases that only about 1 per cent were motivated in their acts of delinquency by any influences of the moving picture. The latter does not give any percentage figure but says that the influence is very small. Blanchard (6), from a study of the children who are brought to child guidance clinics, comes to the same conclusion as Healy and Bronner. These experimenters feel that a child, after seeing murders, robberies, and other misdeeds on the screen, may be influenced to do likewise in make-believe play, but that it is a rare thing to find that he actually imitates the crime. Aguirre (1*d*), working in South America, says that scenes of violence depicted in the moving pictures may play some part in the development of nervous disorders, which in turn may lead to increased tendencies toward delinquency, but no facts are given on actual cases where the connection between moving pictures seen and the delinquencies committed are at all clear. Hartshorne and May (25) asked a large number of children to state the frequency with which they attended moving-picture theaters, and then correlated the frequencies thus reported with the scores of these children in cheating tests. The correlation was +.17,[11] which indicated that there was only a very slight tendency for

[11]Of course, it is possible that the children's report on frequency of attendance may not be reliable. But any correction for overstatement on the part of those who cheat most, which would seem to be the most probable constant error, would tend to make the true correlation lower than .17.

those who said they attended most often to cheat most. The evidence that is available, therefore, does not prove that moving-picture attendance is an important factor in accounting for delinquency in any obvious way at least, nor that it influences in any appreciable degree that aspect of moral behavior which is measured by tests of dishonesty in school. However, since any influence which might be exerted by moving pictures would probably be rather specific, it would be hazardous to generalize from the results of these studies concerning the probable effect on rather specific attitudes or on other "traits" such as persistence, industry, cooperativeness, self-control, and the like. Thurstone (69*a*) has shown that the attitudes on a specific matter like gambling have been changed as a result of seeing a picture featuring gambling. The change was in the direction of judging gambling more severely, which Thurstone says was surprising in light of the nature of the picture. Peterson and Thurstone (49*a*) present evidence to show that children's attitudes toward German people changed in the direction of greater friendliness—the expected direction—as a result of seeing the film *Four Sons*. The shifts in attitudes toward other national groups were only negligible. Such clear evidence on the specific attitude changes attending particular pictures makes one wonder if the results of Healy, Burt, Blanchard, Hartshorne and May, and others who have dealt with general composite effects may not underestimate the more immediate and more specific effects of certain pictures.

Reading of fiction and newspapers. Experimental facts concerning the influence of reading gangster and blood-and-thunder stories are even more scarce than those on the influence of the cinema. However, the opinions of those most qualified to speak on the question are pretty much in agreement. Healy, who bases his opinion on a very wide experience with delinquents, is very emphatic in his claim that cheap novels dealing with bandit life act as a pernicious influence upon young people. He says: "A definite habit and craving for this type of reading is developed just as the individual develops a habit for alcoholic stimulants. The fires of the spirit of adventure are not only kindled, but are kept going by this fuel" (28, p. 305). It is generally felt, however, that the reading of blood-and-thunder literature is not nearly so harmful as the bandit story, and, indeed, that a moderate amount of such reading may afford pleasure without any ill effects. The excessive reading of cheap erotic stories by young people is looked upon by both Havelock Ellis (13) and Healy as affording undue stimulation toward sexual behavior, which often results in dangerous practices.

The influence of the reading of newspaper accounts of actual crimes has been studied by Fenton (15) and by Hellwig (30). Neither of these writers gives any evidence to show that the newspaper accounts of crime influence unfavorably the moral reactions of young readers. Newspaper reports are not written especially for young people, as are many stories of crime in fiction. Moreover, such accounts, in giving the facts about the crime and the criminal, do not make of him such an adventurous hero as

do the novels. In view of these differences, it is very probable that if they have any bad influence on the morals of children it is decidedly less than that exerted by cheap fiction of the bandit and amatory types.

Motivation in Moral Behavior—The Contribution of Nature and Nurture

So far the discussion has been confined largely to phenomena upon which objective data are available, and it is not our intention in this chapter to venture far from such objective material. But when we come to the question of motivation for moral and immoral behavior we are confronted with the choice of ignoring the problem altogether or of attempting to discover what the general theories of motivation in psychology have to offer which will apply here. In the face of this dilemma it seems best to adopt the latter course, even though the limitation of space will necessitate a sketchy treatment. In the discussion an endeavor will be made to remain as detached as possible from any one "school" of psychological interpretation. But since the theories of motivation have been so much colored by philosophical doctrines and systematic positions in psychology, it would probably be too much to hope that this discussion will be very free from such bias.

The points of view concerning the dynamics of conduct range from that of those who emphasize hereditary patterns of response to that of those who emphasize early conditioning and learning. There are those who believe that all behavior springs from many instincts; there are those who believe in one or two instinct roots from which all specific motives can be derived; and those who believe, like Kuo, that there are no inborn patterns of response of any such complexity as to deserve the name of instincts.

One of the clearest and boldest treatments of motivation from the standpoint of instincts has been given by McDougall (47, p. 17). "The human mind," he says, "has certain innate or inherited tendencies which are the essential springs or motive powers of all thought and action . . . and are the bases from which the character and will of individuals and nations are gradually developed under the guidance of intellectual faculties." He lists among instincts the following: curiosity, pugnacity, self-assertion, self-abasement, reproduction, gregariousness, acquisition, etc. This point of view of looking for the bases of character in certain broad units of hereditary equipment has had very appreciable influence on the thinking of many students of moral behavior and of delinquency. The chief difficulties which have been faced by those who hold this view are: first, the inability to demonstrate what the unitary instincts are, and, second, the failure to show the degree to which the manifestation of an instinct which is noted at any given time is native and the degree to which it is acquired. With the advance of the researches on the processes and results of conditioning, on the one hand, and the growing interest in the integrative behavior of the organism, on the other, the belief in a hereditary

equipment consisting of rather independent, broad, unitary tendencies to action was appreciably undermined.

In the fields of psychoanalysis and of individual psychology there has been a tendency to look for the dynamics of behavior in one or two or three instinctive roots. Freud (18*b*) regards the sex tendency and the self-preservation tendency to be the main elements in human motivation. The sex tendency would encompass all the direct and indirect derivatives of the sex motive whether conscious or "repressed in the Unconscious." The self-preservation tendency would include among other things the protection of all of one's moral and social standards. Adler postulates two universal tendencies: first and foremost is the desire for personal power and superiority; the second is a "social feeling which binds man to man." "With these two points of view," he says (1*a,* p. 190), "we can understand how the relation between human beings is conditioned by the relative degree of their social feelings, as contrasted to their strivings for personal aggrandisement, two tendencies which are always in opposition to each other It is a dynamic game, a parallelogram of forces whose external manifestations are what we call character."

There are numerous other views which have been held such as Dunlap's theory of "fundamental desires," Woodworth's theory of preparatory and consummatory activity as the essential feature in drives, Allport's theory of prepotent reflexes, Janet's theory based on cooperation and respect for age, and Troland's theory of retroflexes. Space will not permit a discussion of these here, but the reader may find a rather extensive treatment of most of them given by Troland (71*a*).

What can we draw from all these theories which will help us to attack the problem of motivation in moral behavior? The first suggestion is that the attempts to reduce the motivation for conduct to two or three pervading tendencies have oversimplified the native equipment of man. Such attempts have derived, in what often seems a forced manner, too much from these two or three tendencies and have not given sufficient consideration to the possibilities that there may be a multitude of unlearned patterns of response, rather than just two or three, which may form the cores for broad tendencies. We know that the child can without training make the responses of sneezing, coughing, and crying, to appropriate stimuli. It seems no less certain that the human organism after a certain degree of maturation has an unlearned capacity to experience a tension-expulsion impulse to genital stimulation. This may be the core of the structure which, when elaborated, has been called the sex instinct. Thus it seems quite possible that there are a *multitude of fine patterns* of actions in the innate structure of individuals and that around these patterns motivations are built up. It is possible also that these patterns differ in strength from individual to individual. Thus two children raised under exactly the same environmental circumstances might not be similarly motivated in the same situation.

The second suggestion to be offered is that the instincts given by Mc-

Dougall, Cyril Burt, and others, and the "fundamental desires" given by Dunlap, and all the supposedly unitary factors in lists like these, are probably products of an intricate combination, elaboration, and integration of a multitude of simpler urges. The mainsprings of moral behavior are probably not few and simple, but many and complicated, and genetic psychology may in the future show us how these tendencies develop and from what innate nuclei. The recent work on conditioning leads us to believe that the influence of training begins much earlier and has much more to do with the manifestation and relative potency of "wants" than the classical treatment of instincts has indicated.

A third point to be made is that motivation for moral behavior is probably not static, but is evolving. This is, of course, in one sense simply a corollary of the conclusion that the motivation of behavior at any given time is dependent partly on training. But, besides this, it seems possible that even the innate patterns change with age due to the process of maturation in the nervous system. Such a study as that of Gesell and Thompson (20*a*), which indicated that growth in climbing ability among young children is to an important extent a process of maturation in neural patterns, suggests that such a possibility is well within reason. The change of motivation with age is well illustrated by the work of Piaget (49*c*), who has studied the nature of the rules made and followed by children in their own games and the reasons why they follow them. He distinguishes what he calls two moralities among children. One he finds in all very young children: an egocentric type of behavior characterized by a tendency to follow rules because they are handed down by elders. He seems to find no tendency for the child, regardless of amount of training, to think of revising rules in games for mutual advantage, and he finds nothing upon which he can build a desire on the part of the child to do this or that because of any "mutual respect of child for child." The second type of morality he finds to have its beginning later in the life of the child than the first, but not suddenly to replace it—indeed it is not infrequently crowded out by the first. It is a morality motivated by a desire to change the rule in a game if in its working some child is not being treated as he himself would like to be. It is the beginning of the desire for creativeness, as opposed to conformity, in moral behavior.

Probably no one would contend that these "two moralities," which we have used to illustrate our point of the changing nature of "wants," are due purely to differences in maturation. But Piaget's observation that the second one never precedes the first, coupled with the common observation that there seems to be no basis upon which to build free cooperative activities in certain games among children below a certain age, leads one to believe that the "wants" of children change and that they change not only through training but also through maturation in neural patterns.

A fourth point which should be made is that motivation is an activity under way in the ongoing life of the organism and not some potential power existing somewhere outside the organism. It is in light of this

consideration that the words, "want," "drive," and "dynamics," seem unsatisfactory as commonly interpreted. A want does not exist except as the activity of wanting which has arisen as a response to some stimulation. Woodworth (79*a*) emphasizes this concept and points to the fact that any activity in progress may be a motive for the time being. The special application of this to motivation in moral behavior is that a child's motivation for lying or cheating at any given time is part of a chain of ongoing activity. His wants must be studied in light of what he is doing. This does not mean that the future is never implicated, but it means that it never is except when some verbalized concept of future activity is stimulated in connection with present activity. It does not mean that such a complex and elaborated motive as desire for social approval may not serve to change the direction of the ongoing activity, but it does mean that something in the ongoing activity must stimulate this desire for social approval before it would ever become a motive force, and it also means that this activity of the moment which stimulates the desire for social approval will determine, to some extent at least, whose approval will be desired.

A fifth point is that emotional conditioning may affect motivation. Bekhterev (5, p. 283) has found in working with children afflicted with kleptomania, "in which the emotion of satisfaction is associated with theft," that reconditioning can take place in just a few sittings so that the feeling of extreme annoyance instead of satisfaction is associated with theft. Watson (77) has found that the emotion of fear may be connected by a conditioning process with situations to which it was not previously connected, and that it may, by the same process, be disconnected from situations to which it was connected. It is interesting that no more attention has been given to this problem in studies of moral behavior especially in view of the fact that the church has made use of it to such an important extent, as have also primitive tribes particularly in connection with adolescent initiation ceremonies. It seems probable that one of the chief effects which literature, drama, oratory, and other arts may have upon moral conduct is along this line of linking certain emotional reactions with certain motivating forces of the individual.

A sixth point which should be raised is with regard to conscious and unconscious motivation. If we leave out of consideration the ethical question as to whether or not behavior resulting from unconscious motivation can ever be considered moral, we may say that behavior in the field of morals is motivated by both conscious and unconscious factors. Very small children lie oftentimes not as a result of any conscious desire to deceive but rather as a regular part of their wish-thinking and romancing. A very large part of the honest behavior of children and adults is a matter of habit, where it would be impossible to say that they are consciously motivated to refrain from lying or stealing. The psychoanalysts have emphasized what they call unconscious motivation in cases where thwartings in certain lines of activity have led to "repressions," which in turn

have led to acts the explanation for which the individual may not understand. Thus a child who has been thwarted in certain desires derived from the sex "drive" may turn to stealing. There seems to be no doubt, from a practical point of view, that the genesis of stealing in particular, and other forms of immoral behavior to some extent, may often be traced back to some important conflict or thwarting which does not seem to be logically connected in the mind of the subject with his undesirable behavior. However, it is possible to lay so much emphasis on this type of situation as to make it seem that almost all moral conduct is motivated by what "escapes from the unconscious." Such a conclusion is open to the objection that it is the psychoanalyst's logical reconstruction of the picture without sufficient attention to all activity of the subject during the period under review. It would seem a simpler and more inclusive explanation to say that this conflict played its part, as did all previous and subsequent factors, in affecting the ongoing activity of the individual, and that it is the ongoing activity at any given time, including conscious processes and habit mechanisms, rather than some entity in the "unconscious," which is the motivation at that moment.

The seventh and last point is that verbalized concepts may motivate moral or immoral behavior. This point is implied in much that has been said about activity motivating further activity. Those who subscribe to the view that no behavior, regardless of how much it may benefit society, can be described as moral unless the motive of the agent was consciously moral, will say that all motivation in moral behavior *must* depend on verbalized, or conscious, concepts. This problem has led to an age-old controversy in philosophy, and we cannot go into it here. Suffice it for our purposes to emphasize the contention that verbalized concepts do motivate moral behavior at times. As shown elsewhere (pp. 524-525), generalized concepts or ideas are gradually built up in accordance with the laws of learning out of experiences which are verbalized. And once these verbalized concepts, or symbols for objects and events, are acquired, they become tools not only for considering the present but for reconstructing the past and planning the future. Through them the distant and the past are made a part of the here and now. With them we build the goals we would achieve. By them great and small characters of the past and present may exert motivating influences upon us, in so far as we have reacted to their actions and their precepts.

At any given time in the presence of suitable stimulation such a verbalized concept, for example, as cheating-is-a-form-of-stealing may act as motivation for honesty in an examination. In the presence of conflicting motivations the ideal of acting-toward-others-as-we-would-have-them-act-toward-us may become for the individual part of the activity in progress and may be the prepotent "drive" in the situation. It would be a mistake to assume that the major part of the motivation in the moral behavior of children was dependent upon the prepotency of such highly complex concepts as the last one named; however, the possibility for such patterns of response to be acquired and to be amenable to stimulation in the ongoing

activities of the individual provides a basis upon which ideals may motivate moral behavior.

Knowledge and Will in Moral Behavior

In popular analysis of moral conduct it is often assumed that knowledge of right and wrong and the "will" to follow the right when it is known are the *sine qua non* of moral responsibility. This assumption is shown most interestingly in attempts made in courts and homes to determine when persons are sufficiently responsible for their acts to deserve punishment for misconduct. Dr. Roscoe Pound (50, p. 586) says: "Our traditional criminal law thinks of the offender as a free moral agent, who, having before him the choice whether to do right or do wrong, intentionally chose to do wrong." This clearly assumes, in the first place, that the individual knew which act was right and which wrong, and, in the second place, that the individual freely willed to do the wrong. We may take one more quotation showing the view of the courts. Sir James Fitz-James Stephen (61), writing on criminal law in England, says: "No act is a crime if the person who does it is at the time when it is done prevented by defective mental powers or by disease affecting the mind (*a*) from knowing the nature and quality of his acts, or (*b*) from knowing that the act is wrong, or (*c*) from controlling his own conduct." Before the courts, therefore, an individual, whether child or adult, is not considered subject to punishment for any acts committed if it can be established in his case that his mental powers have not developed sufficiently for him to know the difference between right and wrong or for him to have adequate "will-power" to control his acts. When leniency is shown by the court in the punishment of children who are brought before it, such action is based on one or both of these assumptions.

In the home it is often assumed that very young children should not be held very strictly accountable for their acts because they have not reached an "age of discretion." This "age of discretion" is presumably an age at which children know right conduct from wrong and are able to will freely to do the right.

The purpose of this section is to show some of the inadequacies in the above concepts concerning the relation of knowledge and will to moral behavior and to present a discussion of this relation which is more in keeping with recent developments in psychology. In the first place, there is no point in the development of a child at which he suddenly passes from the age of indiscretion to the age of discretion. The results which have already been given on honesty, truthfulness, helpfulness, and the like show that children are not 100 per cent dishonest, untruthful, or selfish at any age, or 100 per cent honest or truthful or helpful at any other age. Children develop gradually in their moral habits and generalizations.[12] A parent

[12]Some evidence on this is presented by Moers (47*a*), who found that children as young as six years of age could make certain important moral discriminations, but that the qualities which parents stressed, such as disobedience and forgetfulness, were the major determinants in the answers given.

who allows his or her child to steal or lie when it is very small, assuming that all habits developed by these responses will be completely obliterated by the actions attending some new and mysterious powers which shall come at some later period, called the age of discretion, is ignoring all that is known about the laws of moral development. A child learns the responses which he makes. A child's knowledge of right is simply a composite of right behavior responses which he has experienced, plus his generalizations based on these. To a four-year-old, knowledge of right consists of knowing that he should "say please," "say thank you," "not hit little brother," "not pick up things in stores," etc. When he is fourteen, his knowledge of right will differ from this not in kind but in degree. He will have had many more experiences where questions of right and wrong were raised. He will have a large and more complex list of right responses and of wrong responses. He will have classified, verbalized, and generalized his responses more, but he will still be facing many novel situations which are so complex that he will not know what is right and what is wrong.

Jones (35) presented written descriptions of 64 childhood situations to 177 children of Grades 7 and 8. The instructions were that the proposed action in each situation should be marked as "right," "excusable," or "wrong." There were only 9 situations out of the 64 where as many as 90 per cent of these children agreed as to the rightness or wrongness or excusability of the proposed action. The same situations (35, 36) were presented to several hundred school teachers and prospective teachers, and among these there were only 12 situations where as many as 90 per cent agreed. These findings have been subsequently corroborated by Maller (42*g*). Even at the college level the question of cheating on quizzes and examinations seems to be a debatable issue with many. The intensive study by Katz and Allport (38*c*) at the University of Syracuse shows that 26 per cent of the students considered "cribbing" to be as bad as lying or cheating but that 22.5 per cent definitely condoned it. The remainder took stands in between these two positions. From these results it may be concluded that persons cannot be divided into two categories, those who know the difference between right and wrong and those who do not. There is no time in life when one is suddenly endowed with ability to discern right from wrong. Throughout life one is continually modifying his views of the right and wrong as he faces new situations.

This leads to the second important point in connection with the influence of knowledge upon conduct. How does knowledge of right in one situation function to help determine what is right in a novel situation? Emphasis has been placed on the importance in moral education of guiding children in specific responses to specific situations. Though the importance of this can scarcely be overemphasized, all of morality cannot be conceived of as mere repetition of isolated learned responses. New issues must be faced, and, as a person becomes older and older, more and more must his responses be made without the guidance of a trainer. What a child will do in facing a new situation will depend partly on his knowledge (considering knowl-

edge as the sum total of one's specific responses to specific situations plus the generalizations based on these responses). One not only learns that it is considered wrong to steal jam at home, a pencil at school, or an apple in a store, but he gradually generalizes that stealing in any situation is wrong. Any line of activity in a novel situation which in his judgment involves stealing will be considered wrong. As an illustration take the case of a boy who for the first time faces the situation of not having his fare collected on a train, due to the oversight of the conductor. The child is faced with the choice of keeping quiet and retaining his money for other purposes or of paying for the service which he is obtaining. In deciding what is right and what is wrong in this new situation, the child may find that in his thinking the paying of the fare links itself up definitely with honesty, and the retaining of the money associates itself with dishonest behavior. If this happens, he is no longer faced solely by the specific choice between paying and not paying, but he is faced by the specific choice as it has allied itself with the "honesty family" or the "dishonesty family." If, as a result of native make-up and of training, honest behavior is greatly preferred to dishonest, the choice between paying and not paying is largely made, once the individual sees how the new problem is related to past generalizations. But the final choice may not be between honesty and dishonesty even, for these may not appear to the child as final traits between which he is to choose. He may look upon honest behavior as a sort of sub-hierarchy in the higher hierarchy of respect for rights of others and dishonesty as a violation of the rights of others for selfish interest. The simplest choice may be made, therefore, by an individual in the light of his most fundamental values. We call this choosing on "principle." But the principle is not some mysterious and suddenly acquired power for knowing right from wrong; it is an acquired generalization based on specific responses to specific situations.

It is an oft repeated fact that knowledge of the right does not insure right conduct. This is so strongly emphasized by some modern writers, however, that one sometimes wonders if they have not overlooked the fact that, whereas one may not will to do the right after he sees it, one cannot choose the right course in a situation except by utter chance if he does not have knowledge. Knowing and willing are so intimately connected that any attempt to set one over against the other is to oversimplify both. However, in practice it has probably been the overestimation of the importance of intellectual factors and the underestimation of the conative and emotional factors which has accounted for more weaknesses in moral training than the opposite. A very appreciable part of one's moral behavior is determined not so much by knowledge and reason as by emotional factors which make certain patterns of response prepotent.

Should the will to do be considered as a new factor in moral conduct? Does it mysteriously throw itself on the side of some acts and against others? Are some people more strongly endowed with will-power than others? Spearman (60) and Webb (78) have concluded, on the basis of

tetrad differences found among various tests and ratings of moral behavior, that a general factor *"w,"* or will, exists. This noteworthy work has served to give mathematical support to the belief that a volitional factor, or volitional factors, may be common to one's behavior in many situations, but this concept of a new factor *"w"* does not seem to be sufficiently analytical to help us very much here. To state that one acts in this manner or that in a given situation because he has a large or small amount of will is merely to re-state the problem and is not likely to stimulate thought and research upon it. If we use the factor or factors of will to explain, then we are faced with the question as to what the nature and genesis of will is.[13] Cannot the will to action be thought of more fruitfully in terms of motivation than in terms of factors *sui generis?* The will to do in a given situation does not seem to be a new force but rather the manifestation of a tendency to act in accordance with the predominating motive force of the moment. There are, of course, individual differences in strength of reactions; there are those who respond relatively weakly to almost all motivation and others who respond strongly. Some authors have ascribed this to "low mental tension" or weak discharges of nervous impulses, some to inhibitions introduced by fear, and some to the gap existing between the end one has in view and the means necessary to accomplish it. If this is what is meant by general will-power or *"w"* perhaps there is no great objection to the name. But willing as ordinarily thought of is characterized primarily not by activity but by directed activity, and therefore it seems best to think of will in terms of motivation. (See the preceding section for a discussion of motivation.)

Some Principles of Learning as Applied to Moral Behavior

The space assigned for this chapter will not permit more than a very brief statement of the bearing of the more important principles of learning on the problem of the development of children's morals.

The Principle of Specificity in Morals. The doctrine of the specific nature of learning which Thorndike has championed in connection with the mastery of various school subjects has a very definite application in the learning of reactions in the field of morals. In his *Psychology of Arithmetic* (68), for instance, he speaks of knowledge of arithmetic as a collection of acquired bonds between specific situations and specific responses. We cannot think of knowledge of decimal fractions as a unitary ability; it is a host of specific "knowledges." The same kind of analysis is most valuable for the understanding of children's moral behavior.

However, there is some difference of opinion as to just how specific learning in this field is. Symonds (62*a*, 62*b*) is an ardent advocate of a most thoroughgoing specificity. For example, he makes a study of the

[13]Spearman has recognized this point but has maintained that the problem concerning the nature of such general factors as *w* and *g* is a question to be answered not by the factor theory but by the sub-theories which seek to explain the general factors. The sub-theories, he says, "do introduce controversial matter" (60*a*, pp. 344-361).

so-called trait "tact" and finds 1173 items which might be considered evidences of tactless behavior, and he implies that all of these refer to specific habits which must be learned if one is to behave tactfully. Hartshorne and May (25, 26), while not emphasizing so much the principle of specificity as it bears on learning, have reported facts on the interrelations among objective measures of moral behavior which are very illuminating. They find that high standing in one test of deception in school does not guarantee high standing on even another school-deception test. The average inter-*r* found among four tests of deception was .39, and the average inter-*r* among honesty, helpfulness, self-control, and persistence was .21. In a study not yet published the writer has found results which agree very closely with these when dealing with a heterogeneous sampling of a grade in a given school population. He finds in a group of 185 seventh-grade pupils (heterogeneous sampling of the grade) the average inter-*r* for three tests of cheating to be .35, and the average inter-*r* between each of these cheating tests and a test of cooperation to be .15. He finds also, as did Hartshorne and May, that the intercorrelations are appreciably lower when a more homogeneous group is used. Allport and Vernon (1*g*) do not believe there is any justification for concluding from such results that specificity is the rule in the aspects of the "traits" measured. They report figures based on fifteen hours of personality testing which indicate that fifty-five of the resulting test scores could be grouped into nine composites and that "each composite of five or eight different subtests 'hung together' or showed a sufficiently high internal consistency to be used as a criterion or standard for some quality or trait." Cushing (11*a*) has obtained an average inter-*r* of .42 among five tests of perseveration and interprets this as meaning "a certain consistency." Many other important studies should be mentioned in this section, such as that by Zillig (80*a*) and that by Baumgartner (4*a*), but space will not permit a further massing of evidence.

It is upon such statistical findings as these that the different opinions about the structure underlying traits have, in the main, been founded. And, in turn, it is upon such interpretations as to the structure underlying traits that many pronouncements upon principles of learning and teaching in the field of morals have been based. It is the writer's opinion that one subjects himself to grave dangers of error when he attempts to determine the structure underlying behavior from correlations among empirical test results. In interpreting an *r* of .35, for example, between cheating in one situation and cheating in another it is hard to say, without a great deal more evidence, whether this is due to a common factor in the individual (such as energy, as Spearman suggests, or pattern or hierarchy), or whether it is due to factors in the two situations which are so nearly identical as to stimulate the same set of specific stimulus-response connections.

Of course it is to be hoped that this controversial issue may soon be settled. But in the meantime it seems that lack of knowledge on this point need not seriously impede research progress in determining how specific

or how general should be the training required to get the greatest growth in moral behavior. There is already rather complete agreement that moral "traits" are not entities which really exist somewhere. When society describes a man as honest, it does not mean that it has observed any unitary trait of honesty, but rather that it has observed honest behavior on the part of the man in a variety of situations, and that it predicts that in further sampling of situations he will respond similarly. Moreover, the studies of learning in the field are in substantial agreement that growth in honest or cooperative behavior consists in reacting honestly or cooperatively in a wide and varied sampling of situations. They lead to the conclusion that children cannot be taught an all-round morality by training in a few situations. But future studies in learning will have to be relied upon to show how many situations will be required and how specific these situations will have to be to bring the learner up to a desired degree of honest or cooperative behavior. The odds are in favor of a middle-ground position. Probably learning in the field will not prove to be such a highly specific process as the most radical exponents of specificity suggest, and certainly it will not be as general as those who dwell upon the building of broad traits believe.

Rewards and Punishments. In all learning, practice is important, but practice does not always make perfect. It makes perfect only when it is attended by a satisfying state of affairs. A child learns desirable moral responses only when satisfaction is associated with those which are desirable and annoyance is associated with those which are undesirable. In practice this principle seems to be pretty generally understood, especially the part about the association of annoyance with undesirable reactions. Too often, however, the type of annoyance used is some form of physical punishment. Undoubtedly, it is sometimes necessary to move down the scale to this low point before one finds anything that really annoys the child enough to get results, but if the child can be made to feel annoyance for an undesirable act on the higher levels represented by a thwarting of the desire for self-approval or the desire for social approval, and the like, it is cruel and often ineffective to move to the lowest level of punishment. Punishment given by adults is often not prompt, not sure, and not calculated to fit the intellectual and moral development of the child. The twelve-year-old Elizabeth Benson, writing in *Vanity Fair* on "Are Children People?" was probably right when she said that "punishment of children often means the giving of vent to the parents' ill temper." Punishment, thoughtlessly and haphazardly applied, will not act as a systematic deterrent to undesirable responses, but, on the contrary, it may lead to license if it is too mild, or to seclusiveness, evasiveness, and rebelliousness if too severe.

Rewards, like punishments, should be adjusted, as far as possible, to the development of the child. In the early period of an individual's development, tangible awards for desirable responses are valuable means for making such responses satisfying, but they are valuable only in so far as they become less and less necessary. A well-known boys' summer camp (12)

tried for three seasons a system of competition and awards, in connection with attempts in character education, but at the end of this period the practice of the use of badges, cups, and elaborate systems of honors or ranks was discarded. The main objections to the system as outlined by the counselors were: (*a*) The danger of establishing and perpetuating habits on the basis of artificial stimulants. Award-winning was often placed by the child above the joy in the experience for its own sake. (*b*) Award-winning conflicted with the performing of acts of service which did not count toward awards. (*c*) Awards depersonalized approval, since there was a tendency for the counselors to substitute the award for personal approbation. (*d*) Awards wore out as stimulants after a child had been in camp for two or three summers. From these observations of practical workers, one would certainly not be justified in concluding that there is no place in moral education for the use of tangible awards and honors, but these observations do serve to call attention to the limitations of such forms of reward.

Where tangible awards and relative ratings are given to children on the basis of their own self-markings, as is being done in an appreciable number of schools,[14] it is difficult to see what is being rewarded. Are the children receiving rewards for desirable moral responses, or for saying that they are moral? Hartshorne and May (25) tested the amount of deception in a school where such a plan had been in use for several years, and found that the children who had been under the system for several terms were more deceptive than those who had been under it only six weeks.

The types of satisfaction which seem to be most universal and permanent consist in receiving social approval and receiving evidence of one's own improvement in some desired direction. Sincere manifestations of approval in the form of words and glances are among the strongest satisfactions for a child when they come from an adult or an associate whom he admires. As one becomes older, he never becomes insensitive to social approval, but a more and more important place is taken by the satisfaction accompanying the consciousness of inner harmony. As Dewey says, "the community without gradually becomes a forum and tribunal within." In the most advanced stages of moral education, the most important function which a teacher can perform in associating satisfaction or annoyance with a specific act is to show the learner new light on the relation of that act to his existing generalized responses which already have strong satisfactions or annoyances connected with them.

Generalized Behavior and Ideals. Mention has just been made of generalized responses, and the question immediately arises as to how such generalizations are built up and how they function in influencing moral behavior. There is a continuity running through all learning, from that of a child's making the simplest stimulus-response connections to that of

[14]The "Knighthood of Youth" method in character education is based on this plan.

forming his most complex ideas of right and wrong upon which his ideals depend. The continuity can at least be hinted at by the following bare outline. When a child makes a response which is judged to be undesirable or wrong in a situation, there come along simultaneously from the parent disapproving gestures, facial expressions, vocal tones, or such words as "don't," "no-no," "that's bad," "that's wrong," and the like. The responses of the adult stimulate the child, and the normal responses to such stimuli are to "stop present activity," "attend to," "shrink from," "avoid," etc. By repeatedly experiencing annoyance in connection with the response, the child is conditioned against it. If the child in the same situation switches over to a response which is judged to be the proper one, his action is rewarded by a smiling countenance, approving gestures, and such words as "that's nice," "that's right," and the like. He has similar experiences on every side, and, just as he learns gradually the uses of objects, he learns that certain acts are looked upon with approval and others with disapproval. Time goes on, and the child finds that there are approved-of or not-approved-of aspects in a large number of situations; he learns that such words as "right," "wrong," "ought," "mustn't," "good," "bad," refer to certain common factors in many situations. No other behavior of his is so violently responded to by adults as this where questions of right and wrong are raised, and consequently no other becomes so quickly and so thoroughly emotionally toned. With the increasing ability of the child to use verbalized concepts goes increasing use of and understanding of the generalizations of right and wrong, good and bad. His first generalizations of wrong are based on a few acts which he has learned are not approved of and which he pronounces in a parrot-like fashion to be bad. But as time goes on he experiences what is called right and wrong in a great variety of situations, and his generalizations are progressively reconstructed. Attending the development of generalized ideas of honesty and dishonesty, of rightness and wrongness, there is the integration of innate tendencies and the development of emotional accompaniments. Here we have the genesis of ideals. The manner in which such generalized responses influence behavior in concrete situations will be discussed in connection with the next section on transfer of training.

Transfer of Training. In moral education, as in all other aspects of education, one of the major problems is that of the degree to which training received in one situation will function in a new and different one. Thorndike's (66) theory, which is perhaps the most widely accepted, is to the effect that the degree of transfer from one situation to another is dependent on the degree to which there are common elements in the two situations. But elements are common only when they are responded to as common, and therefore the more practical question still remains as to how to assist children to see common elements in different situations involving say, honesty. One thing that should be done is to have the child practice honest behavior in its various manifestations in a very large number of different situations. A child cannot from the beginning be taught to be

honest by precept; he must actually face and respond to a variety of situations where different aspects of this trait are involved. This is demonstrated in a learning experiment by Zyve (80*b*), who found that very general discussions of fair play and integrity are not adequate for the teaching of honesty in the self-scoring of test papers in school. But all learning is not a collection of isolated stimulus-response connections; there is the process of generalizing, which has just been mentioned, going on from the very beginning. A second thing which should be done, therefore, is to assist a child to respond to the relations among the various manifestations of a trait in different situations. A third suggestion is that children should be given practice in analyzing out of new situations the familiar elements. The synthetic process of building up generalizations and the analytical process of seeing elements in new situations to which these generalizations apply should go on hand in hand.

There are several experiments which show the importance of the last two points. Bagley (2, 3) reports an experiment conducted by Squire who gave a group of children practice in neatness in arithmetic papers. No mention was made of neatness in other subjects, and no attempt was made to develop an ideal of neatness in general. At the end of the practice period the children showed definite improvement in neatness in arithmetic but little or no improvement in neatness in other subjects. Bagley ventured the guess at that time that if an ideal of neatness in all school work had been developed, in addition to the habit of neatness in the one subject, there would probably have been an appreciable amount of transfer. Ruediger (52) submitted this guess to experimental study. Again neatness was practiced in only one subject, and no mention was made of it in any other school subject. However, provision was made for the teacher to discuss with the children once or twice a week the importance of neatness not only in the one subject in which they were practicing but also in dress, business, home, hospital, etc. At the end of the experiment it was found that, whereas the improvement in neatness was greatest in the subject where practice took place, there was unquestionable improvement on the average in other school subjects. Neatness developed by active practice in one subject transferred over to other subjects when generalizations were built up from the specific responses and when applications of the principle thus developed were made to other situations. Voelker (73), in an equivalent-group experiment, which has already been referred to, found that ordinary instruction given to Boy Scouts in trustworthiness transferred so as to influence to an important degree the actual behavior of boys in new situations.

Jones (37, 38) prepared a group of thirty-nine stories based on the actual moral choices made in childhood by important characters in history, and tried these out in several schools to determine whether or not children would freely discuss practical problems of moral behavior growing out of these stories, and whether or not they seemed to profit in their generalizations from this case-discussion method. The stories were prepared for and

tried out with thirteen- and fourteen-year-old children. In working with this group, it was found that in over 90 per cent of the cases the children who spoke in reply to the question, "What in this story is most interesting to you?" mentioned some moral issue. There was no doubt that the children of this age group were more than willing to discuss practical problems in moral behavior. Whether or not this episode-discussion method led to improved generalizations is difficult to determine objectively. What is a good discussion of moral problems or a good generalization based on such a problem is too much a matter of opinion to justify any dogmatic answer. However, verbatim reports of the children's discussions are given by the experimenter, which show specifically the generalizations which the children did make. Hartshorne and May (26, pp. 248 ff.) conducted an experiment to determine whether or not the use of stories on cooperation and the use of class discussion of cooperation based on the stories would transfer over so as to improve actual conduct. Two experimental and two control groups were used. Objective tests in helpfulness and cooperation were given at the beginning and end of the experimental period, and it was found that in one experimental group the improvement was 48 per cent and in the other 67 per cent, whereas there was no gain in either of the control groups.[15] Another study conducted by the same experimenters (25, pp. 209 ff.) in connection with an attempt to teach honesty by a somewhat similar method showed a very similar result as judged by the superiority of the experimental group over the control group at the end of the practice period.[16]

These experiments lead us to believe that the generalizing of moral behavior is one of the most important means of assuring the greatest amount of transfer of training. Neither the facts from experiments nor any widely accepted theory of transfer of training can be interpreted as belittling the value of reasonable emphasis upon ideals and other generalized

[15]The reliability of the difference between the experimental and control groups was as follows: $\frac{D}{S.D._{diff.}} = 2.7$ for the sixth-grade group and 2.9 for the seventh-grade group.

[16]Two batteries of tests were used at the beginning and at the end of the experiment. According to the results from one of the batteries, more cheating took place on the second administration of the test than on the first in both experimental and control groups, but the increase in cheating was much greater in the control group. It is impossible to say whether or not there were differences in the conditions attending the first and second administrations of the test—such as differences in test-wiseness or seriousness of the children toward the test—which would account for the lower score on the second than on the first administration. But assuming any such differences to be equal in the experimental and control groups, the experimental group resisted more strongly temptations to cheat than did the control group. The reliability of the difference was computed for each battery separately. On the first battery the chances were 9838 out of 10,000 that the children receiving the instruction did better than those in the control group. On the other battery the chances were 7939 out of 10,000 that those receiving instruction did better. Combining the two results, I find that the chances are 238 to 1 or 9958 out of 10,000 that the experimental group did better than the control.

behavior in moral education.[17] However, it should be emphasized that generalizations cannot be built up *in vacuo.* A child cannot be taught honesty without facing a variety of situations calling for honest behavior, or without associating with those who practice honesty. Not only are generalizations never built up without varied concrete experiences, they never function without them. A child must be so taught that he will be able to see fresh possibilities for the application of what he has learned to new and unforeseen situations.

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[17]The common elements which Thorndike refers to in his theory may be very specific habits or they may be such a generalized response as a method of procedure. That he is not referring in his theory exclusively to connections between very minute stimuli and very minute responses is obvious from the following. He says: "There are bonds involving situations and elements of situations which are, in the ordinary sense of the word, general. . . . . Ultimately every connection is between some one state of affairs and some one response. But such elements of situations as . . . . 'feeling that one has done, or has not done, one's best,' and the like are general in the sense of occurring again and again in connection with almost anything else. And to them responses do get bound" (66, Vol. 2, p. 420).

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CHAPTER 12

CHILDREN'S PHILOSOPHIES

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It goes without saying that the child does not actually work out any philosophy, properly speaking, since he never seeks to codify his reflections in anything like a system. Even as Tylor was wrong in speaking of the "savage philosophy" as that which concerns the mystic representations of primitive society, so also one cannot speak, other than by metaphor, of the philosophy of the child.

And yet, however unconnected and incoherent the spontaneous remarks of children concerning the phenomena of nature, of the mind and of the origin of things, may be, we are able to discern in them some constant tendencies, reappearing with each new effort of reflection. These are the tendencies which we shall call "children's philosophies."

In this chapter I should like to emphasize three aspects of these "child ideas," *realism, animism,* and *artificialism.* The intellectual tendencies of the child are very marked in the uncivilized adult, the so-called "primitive." But even with us, if the superficial coating which education has left on our minds be scratched ever so little, we find the same characteristics, at least in the matter of mental orientation.

Child *realism,* in fact all realism, may be defined as a sort of confusion between the inner and outer, or the tendency to fix in objects something which is the result of the activity of the thinking subject. We know how slow to develop is the consciousness of self in a small child. Everything he feels, knows, and sees seems to him common to the whole world and part of external reality. For him nothing is inner and subjective. It is this phenomenon, which continues much later than is supposed, which we shall call child realism.

The first manifestation of child realism is what we might call the confusion of psychic and physical, which J. M. Baldwin emphasizes in his *Genetic Logic* and on which Sully makes some curious observations. Small children have no notion of thought as distinct from material activity. Stern noticed that his four-year-old daughter confused thought with the voice. She said expressly that we think with the mouth and tongue. This spontaneous remark of a child gave us the idea for a systematic inquiry on this point. We asked sixty children between the ages of four and twelve what one thinks with, and whether one can see and touch thought. The results of this inquiry were very clear. All the children under about seven answered, like Stern's little girl, "We think with our mouths." "As for animals," said a little boy of six, "they think with their mouths,

too, all except the horse, and he thinks with his ears, because he hears when you speak to him but he doesn't talk himself." "But," we objected, "you can think with your mouth shut?" *"No."* "Shut your mouth and think of your mother. Can you?" *"Yes."* "Well, what did you think with?" *"With my mouth."*

During the next stage, which lasts from about seven to ten, or eleven, grown-up influence is felt. The child answers that we think with our heads, because that is the current social belief. But, under these words, the child's conception remains spontaneous and in complete continuity with the answers of the first stage. We think with *"a little voice inside our heads,"* says a boy of nine, with *"a little mouth"; "we hear inside our heads,"* says another child. Thought is *"what we make happen."* You cannot touch or see it, but you can feel it with your finger when it comes out of your mouth, etc.

We see how little the distinction of psychic and physical is innate. You may say, it is true, that "voice" is something immaterial to the child. But the following remarks disprove this. *"Can we touch thought?"* we ask a youngster who believes he thinks with his mouth. *"No, it's made of air."* "Where are your thoughts?" *"Everywhere."* And this from a boy of seven: "Can we see it?" *"Yes; you see the wind making the trees and grasses wave; that's thought."*

These explanations are, of course, not spontaneous. Let us pass now to a phenomenon which has struck all children and forced them to explain it to themselves spontaneously: dreams and nightmares. This study not only confirms the foregoing, but proves the existence among children of another confusion or "adualism," as Baldwin calls the confusion between inner and outer things.

Ask a child these three questions: Where do dreams come from? Where is the dream while you are dreaming? What do you dream with? The questions are not chosen at random, but after careful observation. Sully mentions a little girl who would not go into a certain room because *"it's full of dreams."*

The children's replies can be classed in three stages. Up to seven or eight, children think of dreams as coming from outside and fluttering round the bed during the night. *"They're little pictures," "little lamps," "they're lights,"* say the children; *"the moon sends them,"* or *"the street lamps," "the clouds, the sun, the wind,"* etc. These are the usual formulae. The dream is conceived sometimes as light, in which case some source of light is thought of as explaining it, sometimes as smoke, black air, night, etc. To the question, "where are your dreams?" children at this stage invariably answer, *"in the room,"* or *"on the bed,"* or *"in front of me."* There is a very interesting realism here. The child is not taken in by the dream. He soon knows that a dream ship cannot take him on the lake. The dream is conceived as illusory, but he believes it to consist of real pictures—as fairytale pictures are real—and to be in the room. We have tried telling

these children that the dream is in their heads or in them. They answer, *"If it were in my head I shouldn't see it."* One boy of five gave this remarkable answer: *"I'm in the dream. The dream isn't in me."*

The answers in the stage from seven to nine or ten are stronger still. At this age the child is learning that he thinks with his head. He answers that the dream comes from us, from our heads; a dream is *"when we're thinking of something."* He seems to have understood it all. Not a bit of it: he goes on admitting that the dream is in the room; he places it on the bed, a few inches from his eyes. He thinks it is made of air, wind, smoke, or light. One boy said straight away: *"When I'm awake the dream is in my head. When I go to sleep, it comes out."* Naturally we always ask, *"Does the dream only seem to be in the room, or is it really there?"* Children at this stage are convinced that a material image is in the room.

We must avoid interpreting these facts according to our adult logic. They are specific. They are due simply to the child's inability to conceive the dualism of inner and outer. All thought, even false and illusory, belongs to the outside world. It is only towards the ages of ten and eleven that children grow out of this realism and say, "The dream *seems* to be in front of me. It is *as if I saw* something. But there is nothing there."

These ideas of children about dreams confirm what we have said of the realism of thought. But what is this realism itself? Clearly it is a confusion of the symbol and the things signified. As Delacroix has recently shown, all thought is symbolic, and all symbols, to begin with, remain attached to the things they signify. With children this phenomenon is very clear. Ask children how the names of things originated, and they say that the names came from the things themselves, or that the names were made with the things: whoever made the sun gave it its name once for all. You object, "But how did people know that the sun was called that?" The child answers: *"They saw it was called sun, because they could see it was round and hot." "They saw that the clouds were called clouds, because they could see they were all gray,"* etc.

If now you ask the children where the names are, the older ones, from ten upwards, say *"in my head, in my mouth when I'm speaking,"* but the little ones say *"in the things."* The sun's name is *"in the sun."* The child does not maintain that it is written on the sun. He simply thinks that this name is part of the essence of the sun: it is in the sun *"because the sun is bright."* The color, shape, place, and name of the sun are all in the same perspective.

A fourth form of realism is the confusion of perspective proper with the real movements of things. The child thinks that the sun and moon follow him; the clouds, the whole sky goes with him. Here realism sometimes engenders magic.

We ask a boy of four what makes the sun move: *"I do, when I walk,"* he answers. Another boy says, *"It's we who make it move."* Whence can such strange ideas come? Almost all children discover at the age of

three or four years that the sun and moon advance when they advance, stop when they stop. Rasmussen and others noted this in their own children. In Geneva we have found this belief to be general. Here is an example:

Jac (aged 6): "Does the sun move?" *"Yes, when I walk it comes too. When I turn, it turns too. Doesn't it ever follow you?"* "Why does it move?" *"Because when I walk, it walks."* "Why does it walk?" *"To hear what I say."* "Is it alive?" *"Oh, rather! or it couldn't come after me, and it couldn't shine."* After a minute: "Does the moon move?" *"Yes, when I walk, and more than the sun, because when I run she runs too, and when I run, the sun only walks. Because the moon's stronger than the sun is, she goes faster. The sun can't ever catch her up."* (It is true that the impression is much clearer with the moon than with the sun.) "And when you stop?" *"The moon stops. But when I stop, someone else starts running."* "If you run and one of your friends runs the other way, what happens?" *"She goes with him."* After a lot of questions on the cause of movements in general: "How is the sun moving today?" *"It isn't moving, because we're not walking. Oh, yes, it must be moving; because I can hear a cart."*

It is the same with clouds, but naturally the illusion is not so strong in this case.

Beliefs like this comprise two elements. With small children they verge on magic: the child believes that he is making the sun and moon and clouds move, and amuses himself by using his power. With older children the totality is more animist than magic: he thinks the stars follow him in spite of himself, by virtue of their own will. This brings us to the study of animism in the child.

Without wishing to pronounce on the nature of animism among primitive peoples or to enter into the discussion which Lévy-Bruhl has opened on the theories of the English anthropological school, we shall call animism the tendency among children to consider things as living and conscious.

Child animism is much disputed. Some hold that children endow everything with a personality and intentions; others, among them Durkheim, that child animism has nothing to do with the animism of primitives, being much more make-believe than real. For our own part, we have tried to contribute some precise data, taking care, as far as possible, to avoid prejudices and preconceived ideas.

We named a number of objects to the children: a table, a dog, the sun, a stone, the wind, clouds, rivers, etc., asking if each one were living or not, if it knew what it was doing or not, if it could feel a prick or not, etc. This was done to find out to what extent children believe things to have consciousness and intention.

In spite of the obvious drawbacks of this method, it has given some results systematic enough to be noted. Let us begin by studying the child's definitions of the word "alive."

For children between four and six everything active is alive. But as activity is taken to consist in usefulness to man, and as children of this

age are anthropocentric, everything is, in fact, considered as alive. The sun is alive because it gives light, the wind because it moves the trees, stones are alive because you can throw them, the lake because it carries boats, the stove because it cooks the dinner, etc.

The generality of these answers would rob them of interest if an essential distinction did not appear in the second stage. Children of six and seven call what moves "alive" in contrast to what is inert. So the sun and moon, clouds, wind, water, fire, motor cars, and engines are alive, while tables, mountains, and stones are not alive. "To be alive," children tell us, "means that we move." A boy of six saw some dead leaves on the ground and asked if they were alive. "No," he was told; "But," he retorted, "they're moving in the wind." All movement, even induced from without, is a sign of life.

From eight to ten years a new distinction arises, that of original and acquired movement. To be alive is "to move of oneself." Sun and moon and wind are alive, but not the clouds, because the wind pushes them; machines are not, because man sets them in motion, etc.

Finally, at about eleven the child reserves life to animals and plants, or even to animals alone.

It is interesting to note that the replies of children about the consciousness of things develop in just the same way. Everything endowed with consciousness, consciousness restricted to moving bodies, to self-moving bodies, and finally to animals, are the four stages of the process. We need not give examples from all four. Here are a few from children restricting consciousness to things which move of themselves. We ask a boy of nine if the clouds know they are going forward. *"No,"* he says, *"because the wind is pushing them."* "And does the wind know it is going forward, or not?" *"It knows, because it's blowing."* Another child said of the moon: *"Of course she knows she's moving, else she couldn't come back every night."* "Does the sun know he's called sun?" we asked a boy. *"Of course, because it's he that makes the sunshine."* All these answers are alike; things that move of themselves necessarily have consciousness and intention.

We now see that child animism is the result of a confusion or rather lack of differentiation between the psychic and the physical. Just as we saw with realism that the self is very slowly differentiated from things, in the same way things are long endowed with the idea of intention, voluntary effort, living, and spontaneous activity by simple indifferentiation. Child animism, therefore, presents no problem. The real problem is to know how the differentiation is made and how the child gradually grows out of his initial animism. This will be shown by an analysis of the ideas of the cause of movement.

We may note here how far child animism leads us from the ideas of Tylor. Far from being due to the idea of soul or spirit, animism results from the absence of this idea. The child is animist to the extent to which he is realist, that is to say, the extent to which he confuses the inner and the

outer, the psychic and the physical. And it is when, between eight and ten, he becomes conscious of the existence of thought and of its inwardness, that he ceases to be animist.

It is true that, side by side with this very simple scheme, child animism is often complicated by sentimental reactions due to egocentricity and to the constant introjection which this egocentricity implies. This is very clear where the sun and moon are concerned; they are thought of as coming with us on our walks. The moon is "*inquisitive,*" children say, "*she wants to see what we're doing*"; the sun "*looks to see how nice I am . . . . on Sundays, when I'm dressed like a man.*" The moon "*watches us,*" she "*looks to see if we're good.*" The sun comes "*to hear what we're saying.*"

We all know the story, told by William James, of the deaf-mute who associated the moon very closely with his moral life. This child noticed that the moon followed him and watched when he got up to mischief. He thought that he got punished more often when the moon had seen him. Finally he came to believe that the moon was his mother who had died a few years before. The sun seems to play much the same part in the lives of other children.

A more natural way of verifying the existence of child animism, and of finding out how it gradually disappears in the course of mental development, is by questioning children on the cause of movements which they have observed. The verbal inquiry described above has shown the extreme importance of movement in the child's conception of life and consciousness. This further way is a rich source of spontaneous explanations.

We may say that up to seven or eight the real cause of movement in nature, for the child, is a moral one. Natural law is still the social law. In its most primitive form this phenomenon partakes at the same time of magic and artificialism. The clouds are thought to move because of us, we make them move by walking. Or else people make them come because it must rain. The moon comes back every night because we must be able to see. Streams and rivers run because we must have water. If the child has noticed that they always run in the same direction, he says it is because there must be water in the lake. Moral obligation is enough to explain the movement. If we show surprise at this explanation and make the child be more precise about this power of man over things, he invents myths. He says that a man throws the sun and moon, so as to make them move, or that men send the rivers on with the oars of their boats.

Of course, these explanations imply animism. They imply that the things obey, that the moon knows when she must come back, that the streams know where the lake is to which they must run.

During a slightly more developed stage of these moral explanations, the artificialism is transferred to the things themselves. The child's explanation at first appears to be mechanical. He declares that the clouds send the sun or moon along, that the pebbles send the stream along, that the clouds move because of the moon, or the rain, or the night, etc. But

if we examine these explanations a little more closely, we find that they are all quite finalistic, or even moral.

When the child believes that the sun and moon move because of the clouds, he admits a kind of struggle between good and bad weather; the sun must go when the clouds come, and the clouds must go when the sun comes back. The cause of the movement is still moral. Or when he says it is the night that makes the clouds move, he simply thinks that the clouds must come so as to make the night. In fact, for children, as for the early Greek thinkers before Empedocles, night is a black vapor, a great black cloud which fills the atmosphere. To say that the clouds come on because of the night is to say that they have the moral obligation to come, so that little children can go to sleep.

When the child says that the stream advances because of the pebbles, the explanation is more curious still. He has seen that stones sticking up to the surface of the water produce waves and rapids; from this he concludes that the water "takes a run" to get over the stone. The stone is the obstacle which excites it. If there were no stone, says the child, there would be no stream. The stone is the cause of the stream of water as the hurdle is the cause of the horse's jump. The spontaneous questions of small children reveal this tendency of their thoughts at once. A boy of four asked one day, "Auntie B., how do the streams take a run to start with?"

We see how, in these primitive stages, movement remains spontaneous and close to life itself. During a second stage the child arrives at the idea of the need of an exterior physical cause or transmitter of movement. Actual physical cause thus succeeds the moral cause. But an interesting thing is that this physical cause does not begin with simple forms. With children it takes on the complicated appearance which characterizes the physics of Aristotle, and which Meyerson has called the scheme of "surrounding activity."

We know how Aristotle explained the movement of projectiles. The motive force, he said, is itself motor. In moving it moves the surrounding air which flows back behind the moving object and pushes it forward. It is this kind of reciprocal action or the shock and return of the air current which is called "surrounding activity."

Bizarre as it may seem, this is exactly how children between the ages of seven and nine explain movement to themselves, that is to say, when they are making their first attempts at physical explanations.

The phenomenon is clearest in the case of clouds. The clouds, says the child of eight, move forward because of the breeze they make. Here are some examples. One boy told us, *"It's the wind that drives the clouds along."* "But where does the wind come from?" *"From the clouds. They make a wind."* "How?" *"By moving."* And a little girl: *"It's the wind that pushes them."* "Where does the wind come from?" *"From the clouds."* In the most primitive cases the child believes that the wind comes out of the clouds as though from the sack of Æolus, and that this

wind sends the clouds along. But in the most developed cases the child says plainly that the clouds make a wind *"by their movement"* and that the wind pushes them.

It is the same with the sun and moon, but not so frequently. Children have said to us that the sun and moon make a wind as they move, and that this wind moves them along. The same is true in the case of streams and waves. The stream of water is thought to produce a stream of air, which is believed to cause the movement of the water.

To understand these curious facts one must know that for the child the cause of the wind is the thing which, to our minds, is moved by the wind. If you ask a child of five or six point-blank, "Where does the wind come from?" he answers, "From the trees," thinking that the trees sway to make a wind, or he says it comes from the clouds, the waves, or even from the dust. Sully had noted this fact, which our investigations have shown to be quite general.

We had the curiosity to lay before children of from eight to ten the problem which preoccupied Aristotle, that of projectiles. "Why," we asked, "when you throw a ball does it go on, instead of falling on the ground at once?" Strangely enough the children thought of Aristotle's explanation. "The ball goes on because of the wind," and this wind is caused "by the movement of the ball."

It is only at nine or ten that the child discovers the real cause of the movement of streams; then, too, he leaves off applying the theory of "surrounding reaction" to the sun and moon.

Our last problem is that of the origin of things and child artificialism.

We know how interested children are in the problems of origin. "Who makes the sun?" asks a boy of two years nine months. "Who made the air? the earth?" "How is thunder made in the sky? Are there all the things to make fires in the sky?" "Where do stones come from? glass? wood?" "Who made the birds?" These questions abound with children between four and five years old.

Often these questions arise from curiosity about birth itself. "Mummy, where was I before I was born?" "Where do babies come from?" "How are ladies made?" "And people, how are they made?" A few questions from among the hundreds published.

To understand the spontaneous thought of the child it is most important to know what these questions really mean, and what are the child's ideas on the origin of things. To solve this problem, we asked some hundreds of children between four and twelve years of age questions such as, "How did mountains and rivers begin?" "Where do clouds come from?" "Where does rain come from?" "How did the sun begin?" etc.

Some of these questions may seem strange; to ask children how the sun and moon began may seem a psychologist's mistake. We felt this so strongly that it was not without timidity that we at first ventured on them, expecting the children to laugh at us. But, as a matter of fact, the more primitive the mentality, the less it feels the difficulties of the problems.

The children had no more difficulty with questions of cosmogony than with those treated up to now. Moreover, the answers were very uniform and advanced progressively with the age. This is a double guarantee that the method is well founded.

The explanations of the origin of things offer two stages of development. The first is artificialist or theological; for the child, man made nature. The other tends to become natural: things derive from each other by generation, which comes nearer and nearer to causality by identification.

The first stage, up to seven or eight years, is extraordinarily fertile in artificialist myths, the details of which are all more or less fabulous. The child believes, for example, that the sun and moon are great balls which men have made, lit, and thrown into the sky. One boy of six told us: *"The sun began when life began."* "What do you mean?" *"When we began to be alive."* "But how did the sun begin?" *"By a match."* Another boy said that the sun was a big round stone that a gentleman had lit. "But how does it stay in the air?" *"Because the gentleman threw it into the sky."* As for the moon, she is continually being remade. Children take her quarters to be so many new moons. "A gentleman made half of her first, and then the rest."

These answers give the impression that the children are telling stories without believing them themselves. But let us remember William James's examples of the childhood recollections of deaf-mutes. The deaf-mute D'Estrella, after puzzling over the origin of the sun, had a sudden revelation on seeing some boys playing at throwing lighted torches into the air. Then he imagined a great strong man, standing behind the hills of San Francisco, who for fun threw a lighted ball into the air every morning and caught it every night.

Child artificialism and animism are, moreover, allied here quite naturally. Sun and moon are for the child both fabricated and alive. The same children who talk of the sun's being made believe that it follows and watches them. The children who think the quarters of the moon are moons that are being made speak of the moon as pushing. A boy of six said, for example, *"We have to be babies before we can grow up, so the moon begins by being quite little, and afterwards she gets big."* A boy of nine who declared that the moon pushed so as to get bigger was quite troubled when we asked him how the moon began. At last he got very red and said that she came from the person who made her, and that the person who made her was a gentleman. Obviously he was a child who had been forbidden to talk about birth and was as embarrassed in talking of the birth of the moon as of that of any small animal.

This strange idea of the making of a living thing is only contradictory for us. Children, in general, consider the birth of a baby as the fabrication of a living thing. "What do you do to have babies?" asks a little girl of six, and adds, "I know. I'd go to the butcher. I'd buy some meat and shape it out of that." Or a small boy asks his mother, who intelligently tells him the truth. But truth is not always comprehensible, and

a few days later he asked, "But mummy, how did you make my little hands? And my little head and feet?" And this decisive remark from another child who had been told the truth, "But how do mothers manage to put their hands inside them to make the little babies?"

This shows how the ideas of birth and fabrication are primitively linked for the child. It is therefore not surprising to find that all the bodies which the children have just spoken of as living and conscious are now considered to have been made by men.

The wind, for example, is caused by fans or bicycle-pumps. Or "there was a gentleman who has blown a lot." The clouds were made by masons out of earth or stone. Then, when the child realizes that they must be light, he thinks they are made of the smoke coming from the chimneys. If there were no houses there would be no clouds, and the sky would be always blue. The sky itself is a great dome made by men, and if it is blue it is because it has been painted. Rain comes from pipes and taps situated above this dome. Rivers, lakes, and seas were dug by men, and water put in them. The mountains were built, or rather, hills were built and then went on growing by themselves. Stones are made of earth pressed together, and earth of pebbles crushed into powder. Trees come from seeds which shopmen make, and there is red, blue, or green, etc., put into these seeds for the flowers and leaves.

We will not insist too much on the varieties of these conceptions, for the flourishes are naturally open to the suspicion of invention. But let us separate the roots of this artificialism. These roots are essentially two in number. On the one hand, there is child egocentricity and the complete finalism to which it leads. It is well known, since Binet and Simon, that children define everything "by its use." The sun for them is "to warm us," the moon "to make a light at night," the mountains "to go for walks on," the rain "to water the garden," "to wash the streets," the wind "to push the ships," "to make the clouds come," etc. Therefore, if all nature is made for us, if it shares in all human activities and purposes, it is natural that questions of origin should be solved by the child in an artificialist sense. Nature is made by man to the extent that it is made for man.

There is a further point. Bovet has shown, in his penetrating studies, that there exists among children, at least among the very little ones, a spontaneous religion: the religion of parents. Parents are omniscient, all-powerful, eternal. From this to the idea that man made the universe is only a step. The conviction that his parents have organized the best possible world for him leads the child to conceive all nature as organized according to a plan and constructed by man himself.

What then produces the decline of these artificialistic beliefs? The child will seek to explain nature by himself, without the aid of human activity, but these artificialist tendencies are too strong to be eliminated all at once. Artificialism will then still partially exist but will be transferred to different things. Along with the survivals of animism, this

inherent artificialism will thus give birth, in children from the age of about seven to eight years, to a type *sui generis* of explanation, which leads us towards causality for identification and which we shall call the causality by generation. The child of eight to nine years, in reality, conceives the various objects of nature as issuing one from another without so much as stopping to consider whether they are living.

Take the stars, for example. The sun and the moon, the boys of nine tell us, are in the clouds. They are the little red clouds which press close together and make themselves into a ball. The reasons these children give are very interesting. Sometimes they point out the golden clouds that one sees at sunset and which to them appear to be made of the same substance as the sun. Sometimes they remark that the moon when seen by day looks like a very thin white cloud. Other children consider the stars are like pressed and ignited air; others consider them as smoke which has once more become fire.

We realize how interesting these explanations are from the historical point of view. Indeed, they intimately recall the conceptions of Anaximandre, Anaximène, and other pre-Socratics.

Still further: At this age the children explain the clouds as being air which is pressed together, as air becoming water and changing itself into rain. They explain rock as being earth made hard and the pebbles as being formed of all the little twigs. One sees how very readily the law of identification recalls the law of condensation and rarefaction belonging to the pre-Socratic school.

At this juncture it may be well to make certain experiments on the genesis of the principles of conservation in the child's natural philosophy. We show the child two pellets of clay or plasticine having the same form, the same dimensions, and the same weight. In full view of the child we then make one of these into a long sausage, leaving the other in its original shape. We thereupon ask the child whether the two lumps of clay have the same weight. If the child doubts it, we should then ask him whether they still consist of the same amount of clay or not.

The results of the experiment are very clear. Before the age of seven years the child believes that the sausage is not so heavy as the ball and that it contains less clay. The child then has neither the idea of preservation of material nor that of preservation of weight. From seven to ten years, the child still declares that the sausage is lighter than the ball, but he thinks that it contains the same amount of clay. The idea of preservation of material has then made its appearance, but not that of preservation of weight. On the other hand, the law of condensation has appeared: at this age the child declares that a pebble is heavier than a piece of wood of equal volume, because, he says, the pebble is more *pressed* or more *full*. Finally, from ten years on, the ball and the sausage of plasticine are considered as being of the same weight, and the child even finds the question which we put to him strange, as the answer seems to him so natural.

We see how a progressive rationalization of the child's idea of the world follows an artificialism and primitive animism. This rationalization, about which we must say a few words, becomes especially appreciable through the following processes.

Instead of contenting ourselves with having wholly verbal conversations with the child, we may institute little physical experiments on which he is questioned. The most simple experiments are, in this respect, the best. The very general result that we have obtained is that the child's thought proceeds from dynamism or from substantialism to a mechanism more and more founded on logical relations.

Here is a first example. We show the child a glass three-quarters full of water. We also show the child a stone and ask him what the water will do when we drop the stone into it. We suit action to words and ask the child to explain the result. Strange as it may seem, it is only from nine to ten years of age that children are capable of giving a correct explanation, that is to say, of understanding that the level of the water rises because the stone is large and takes up space. The youngest children, on the contrary, have recourse at the outset to a dynamic explanation. They pretend that the water rises because the stone is heavy, and that, being heavy, it weighs down the water and produces a current, this explains why the water rises. In that, there is not only a verbal shade of meaning. These children believe, for example, that a little nail will make the water rise higher than a block of wood because the nail is heavy. Moreover, they suppose that a stone immersed but held by a thread so that it does not touch the bottom will not make the water rise. For them it is the pressure of the stone on the bottom of the glass which produces the current.

This direction of dynamic thought is very clear in the case of the floating of boats or the suspension of clouds. For children of four to nine years, the boats float, not because they are light, but because they go quickly. If they stopped they would sink and if they are able to stop for a short while it is because they have enough "go" for that. It is a case of a gliding flight, as it were. In the same way, if the clouds remain suspended in the air, it is not because they are light. On the contrary, they are considered as being heavy. It is because they go fast enough to be held in position by their own movement. They fly. It is only at about the age of nine to ten years that the ideas of weight and relative weight appear and permit of correct explanations. In following this evolution, we can clearly distinguish two aspects. On the one hand, from the logical point of view, weight is less and less considered as an absolute; it is progressively connected with volume. On the other hand, from the physical point of view, the mechanical explanation gives way, little by little, to an animistic dynamism.

Another striking example is that of shadows. With the hand or a book we cast a shadow on the table in front of the child, and ask him to explain what he sees. We also ask the child to foretell from which side the

shadow will be produced in relation to the source of light. Here, again, the evolution of the responses comes very clearly from dynamic substantialism or from mechanical relativism. We can distinguish four stages in these replies.

The first stage is characterized by a sort of reasoning by participation, akin to the manner of the primitives. The child declares, for example, that the shadow produced on the table comes from under the trees or from the sky, that is to say, from night, or from the depths of the room. In other words, for him there is not only identity of substance between the shadow produced and all the other shadows in the universe, but also direct action one with the others. It is sufficient to put a book above the table for a piece of the sky or a fragment of shade hanging under the trees to rush to take up a place under the book.

During the second stage, the child renounces these participations, but, for all that, does not abandon the idea that shadow is a substance and that this substance moves about by itself. For the child the shadow comes from the hand, or from the book, and it can take its place on either side, no matter which. The relation between the shadow and the source of light is not understood at all.

During the third stage, this relation is, on the contrary, distinctly perceived. The child realizes that the shade is always on the side away from the window or the lamp. But the child still continues to believe that the shadow is a substance issuing from the book or from the hand. If this substance makes for the side away from the daylight it is because the shadow is black and flees from the day.

It is only during the fourth stage, that is to say at about nine to ten years, that the shadow is clearly understood as an absence of light, and that the object, the cause of the shadow, is considered as a simple screen. We thus see how these various actions converge to show the progressive abandonment of dynamism in favor of rational and mechanical explanation.

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PART IV

FACTORS THAT MODIFY CHILD BEHAVIOR

CHAPTER 13

ORDER OF BIRTH

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The position of a child among his brothers and sisters (order of birth) has long been regarded as a factor influencing development. While popular beliefs show little consistency with regard to this problem, in the social practice of communities we find many examples of discrimination between the children of different birth orders. It is likely that such differential treatment, as in the case of primogeniture, arose from economic and political considerations rather than from any general convictions as to the superior fitness of members of a given birth rank. Primitive societies organized under an individualistic technology were disposed to favor an equal division of personal property and of land at the death of the head of a family. Societies which were more dependent upon joint effort resorted to various methods of insuring the continuity of a primary group or of a larger political unit; joint management by co-heirs was sometimes tried, but with less effective sanction than inheritance vested in a single one of the survivors, usually the eldest son. Primogeniture, however, had its exceptions; in the so-called "Rule of Borough English," succession passed not to the eldest but to the youngest son; this practice has survived into modern times, with an origin based apparently upon very early tribal usages. Laws of primogeniture were at least nominally in effect in most of the American colonies, although the oldest son was sometimes limited to a "double portion" rather than given a sole equity in the estate. The legal basis for such discriminations passed out of existence as a result of the Revolution.

During the past fifty years numerous studies have appeared dealing with various aspects of the problem of birth order and attempting to determine if there is scientific justification for a belief in differences due to position in the family. A complete list of these studies would include over two hundred and fifty titles, the majority of which are concerned with the relation of order of birth to physical traits and to the incidence of disease. The problem has received attention from such investigators as Galton, Pearson, Havelock Ellis, Yule, Rivers, and, in the United States, Boas, Cattell, Terman, and Thurstone.

From the standpoint of psychological theory, the existence of birth-order differences in such a trait as intelligence would be of considerable interest. Such differences must be epigenetic rather than hereditary in

their origin, arising from environmental factors which influence either the trait in individuals or the distribution of the trait in the group (through selective mortality). For the educational psychologist and for the rapidly growing company of specialists in child development, a very real importance would attach to inequalities among the birth orders, in physique, intellect, or in other traits of personality; even a slight difference could be taken as pointing to significant environmental correlations, and to the possible existence of individual cases in which marked effects have been produced by conditions associated with birth rank. Assertions have also been made that the problem is one with direct implications for the welfare of the race; a cumulative dysgenic effect would be expected if the earlier-born are biologically inferior, and if their proportion in the population were to increase as a result of a diminishing birth-rate. Pearson, whose views on this matter are well known, goes so far as to state:

> "If our observations are correct, and I believe them to be so, then the mental and physical condition of the first and second born members of a family is differentiated from that of later members. . . . The result of this law is remarkable. It means that if you reduce the size of the family you will tend to decrease the relative proportion of the mentally and physically sound in the community. You will not upset this conclusion in the least, if, as I suspect, the extraordinarily able man, the genius, is also among the early born. For you will not lose him, if you have a larger family, although you will lose the sounder members if you curtail it" (62, pp. 20-21).

It may be observed that much of the literature in this field is of a controversial, sometimes ill-tempered, trend. The problem is extraordinarily beset with pitfalls, and because of this fact it seems necessary to devote a considerable portion of this chapter to a discussion of methodology. We shall begin with a survey of some of the possible sources of error involved in the collection of data and in the statistical analysis of results. In this section some reference will be made to non-psychological studies, partly because of their usefulness in illustrating good or poor technique, and partly because their results show selective factors at work which the psychologist must take into account in his investigations.[1]

The Definition of "Birth Order." This is subject to varied usage. By some writers it is taken to mean the order of birth of living children —a definition which in certain cases may be justified if the purpose is to study the effects of social relationships within the family. Cyril Burt and others have defined the only child in social terms, i.e., a child with siblings being counted as an only child if the natal intervals and the home circumstances appeared to justify it. The chief danger in this procedure lies in the subjective factor in classification; it may be difficult to resist a

[1]For a brief review of birth order in relation to physical traits and health and disease, see Holmes (45, pp. 297-324). Later reviews on these topics are given by Hsiao (46, Chap. 2), and by Thurstone and Jenkins (80).

temptation to circular reasoning, with the result that children with "only-child characteristics" are thereby placed in the group assumed to be socially only children. It is customary among most writers to assign birth numbers on the basis of all children born living, counting post-natal deaths, but excluding stillbirths. Where an attempt has been made to base results upon pregnancy order, account is taken of stillbirths and miscarriages, and, in a few cases, of abortions also; as a rule, it has proved extremely difficult to obtain reliable data on these incomplete or unsuccessful pregnancies. In one instance, in the case of physical traits (length and weight at birth), results in terms of pregnancy order have been compared with results in terms of living births, but without showing any significant differences from the two modes of treatment (Harris, 42). Hsiao (46, Chap. 4) has reported that, in a representative school population, approximately 15 per cent of those identified as first-born may actually be expected to be second children in terms of pregnancy order, and that 15 per cent of the "second-born" are third children.

The Use of Marked Cases and a Control Group. In the study of marked cases, the incidence of a given trait (taken as an entity) is stated in terms of the proportion of children of each birth order who show the trait. Thus, in the pioneer investigation by Sir Francis Galton (34) of the birth-order distribution of English men of science, it was found that the highest percentage of eminent men occurred among scientists who were eldest sons. The conclusion suggested by this was that for social or other reasons the first-born have an advantage over later-born in the probability of becoming distinguished scientists. But we must hesitate to accept such a conclusion until we have determined the relative frequency of eldest sons in the general population; it may be that the excess number of first-born in science reflects merely a surplus of first-born in the community.

In an attempt to deal with this statistical issue, an obvious device is to draw a control group from the general population. An early study of mental defect by Mitchell (59) compared the proportion of first-born among a group of idiots with the proportion of first-born in the communities from which they were derived. Since 33 per cent of the idiots and only 23 per cent of the generality were first-born, it would appear that idiocy falls more heavily upon the eldest child than upon his younger brothers and sisters. But here again we must suspend judgment until we have tested the comparability of the control group. Consider the following example of invalidity in a control: If a classification is made of problem children in a school which represents a superior social group, the percentage of these children who are first-born will be in excess of a normal quota, i.e., the quota derived from the enrollment of first-born in a wider sample of schools. This surplus of first-born would be expected on a purely chance basis in view of the fact that upper classes limit their families and thus, as compared with the generality, have a higher proportion of children in the earlier orders of birth. But, in view of the

varying correlation between birth-rate and social status[2] and the inadequacy of our methods for determining social status and for equating groups, it seems wiser to avoid using an external control as our sole criterion. An alternative method is to compare the proportion of marked cases that are first-born with *the proportion of first-born among the siblings of all the marked cases.* Even here we are by no means free from statistical pitfalls, as has been shown in the controversial literature of Pearson, Hansen, Greenwood and Yule, Macauley, and Dublin and Langman (46, Chap. 2). When we have determined the percentage, for a given trait, falling in each birth order, our further task is to compute a "reconstruction," which will give the expected relative frequency in each birth order for the actual families of the marked cases. This reconstruction should take into account the factor of size of family, the chance of marking for each size of family, and the possibility of a differential mortality among the various birth orders. The need for these complicated statistical procedures is wholly avoided if the investigator can extend his study to include siblings in his actual data collection and not merely in his expectancy tables. In recent years, more attention has been given to studies which involve a quantitative measurement of traits rather than an all-or-none division, and to studies which attempt to base conclusions upon the comparison of siblings.

The Effect of Size of Family. Certain of the factors under this heading have been discussed in the preceding paragraphs in connection with the relationship between birth-rate and social status. Implicated in this is the well-known negative relationship between size of family and intelligence,[3] the effect of which may be very clearly noted in a study by Sutherland and Thomson (77). In a large unselected group of eleven-year-olds on the Isle of Wight, these investigators reported a correlation of —.20±.019 between birth order and intelligence, indicating a slight but statistically reliable tendency for lower IQ's to occur among the later-born. This tendency, however, was shown to be chiefly, if not wholly, due to the fact of a smaller average intelligence in the larger families; or, in other words, the unfavorable weighting of the later-born is an outcome of the unfavorable weighting of large families. In applying this

[2]Chapman and Wiggins (21) have reported a correlation of —.27±.025 between family size and social status. From numerous other studies such a result appears to be fairly typical for an unselected population. In special groups, however, the correlation may drop to zero or become positive. Compare the discussion by Thurstone and Jenkins (80) of Edin's report on the population of greater Stockholm. Here a new equilibrium appears in the process of being established, with a very low general birth-rate, and a tendency for the "upper" classes to have larger families than the "lower" classes.

[3]Chapman and Wiggins (21) found a correlation of —.33±.024 between size of family and IQ; the coefficients were —.22 and —.24 when American and foreign families were considered separately. Bradford (12), in a group of 400 urban children, reported an *r* of —.25±.03. For groups of varying degrees of homogeneity, Sutherland and Thomson (77), Clark (22), and Slawson (70) have reported correlations ranging from —.02 to —.22. In a relatively stabilized rural population, Conrad and Jones (*23a*) found no relationship between intelligence and family size.

important principle, we must bear in mind the fact that the regression of intelligence on family size is by no means a constant for all groups. Among 1854 clinic cases at the Institute for Juvenile Research in Chicago, Thurstone and Jenkins (80) have shown that, for individuals with an IQ of 65 or above, the correlation between intelligence and family size is $-.188 \pm .018$, but in the more defective portions of the population, with IQ's below 65, the correlation shifted to $+.158 \pm .028$. This repeats a situation which has been noted in the case of epilepsy (Pearson, 63) and schizophrenia (Rudin, 67), namely, that the first-born appear more often to be affected by these abnormalities, but this is chiefly because small families are pathologically weighted. In relation to the foregoing, Brugger (15*a*) has reported that when two or more congenital defectives appear in the same family, their average natal interval is greater than that of normal siblings.

It is not surprising to find a low fertility, with few representatives in the later birth orders, among certain grades of inferior stocks; a biologically serviceable weak fecundity may be supplemented by the effects of late marriage and of direct limitation. The voluntary restriction of family size, aside from its differential effects in groups of varying intelligence and social status, has a further consequence in the case of pathology of the last-born; in many families the appearance of a deviate individual (e.g., a Mongolian) automatically marks that individual as the last in his sibship.

The Effect of Incomplete Families. It is obvious that later-born children are more numerous in complete than in incomplete families. Hence a study of marked individuals involving incomplete families is certain to yield a spurious weighting of the earlier-born, unless precautions are taken to guard against this type of error. Strange to say, such precautions have not always been taken, nor has the need for them always been recognized. One method of reducing the differential influence of incomplete families is to analyze the data according to constant age of the mother (by direct grouping, or by partial correlation), for in a given social selection the completeness of families is undoubtedly closely associated with this factor.

The Effect of Mother's Age. In the preceding section, the age of the mother was mentioned as a variable related to the completeness of families, which, in turn, is a determinant of the frequency of each birth order. The age of the mother, however, may be more directly implicated in the weighting of the birth orders. This is a complex matter to control, for the incidence of a trait in a given birth order or its average value on a quantitative scale may involve joint contributions from mother's age and from birth order acting as independent variables. These factors may vary in relative force, at different ages, at different birth positions, and in different social groups.

As an instance of the mutual relation of the age of the mother and the position of the child in the family, Elderton (28) has found that the offspring of very young mothers are particularly prone to a heavy infant

TABLE 1

INFANT MORTALITY IN RELATION TO ORDER OF BIRTH

Order of birth	Crude death-rate, percentage of average of whole population	Influence of mother's age eliminated	Single births. Influence of mother's age and father's earnings eliminated
1	94.2	92.7	99.4
2	86.1	88.0	90.2
3	94.1	97.6	98.2
4	97.8	101.2	99.6
5	106.8	109.0	103.7
6	110.3	109.7	96.0
7	123.0	118.4	112.6
8	122.2	115.2	104.7
9	132.0	120.2	111.9
10 and over	163.2	142.0	130.6

mortality if they occur in the later birth orders; but, on the other hand, for the offspring of older mothers the heaviest mortality falls among the first-born. An illuminating discussion of this matter is given by Thurstone and Jenkins (80) in their treatment of Woodbury's material on infant deaths among approximately 23,000 cases (Table 1).

> "The first column gives the crude death rate (live births) of each ordinal number expressed in per cent of the death rate which would be expected if there were no favoring of any ordinal number; i.e., the mean death rate for the whole infant population. If there were no pathological weighting of any birth-order position, the death rate for each ordinal number should equal the mean death rate for the whole group and each percentage should be 100. . . . The table indicates a higher mortality for the first-born than for the second, which is perhaps partly due to the factor of mother's age. There is a heavy mortality for the late ordinal numbers, in a large part due to the influence of age of mother and to the lower family incomes frequently received by large families."

Twinning is an example of a trait which at first sight appears to be dependent upon birth order. Numerous papers have appeared on this topic since Duncan's first contribution in 1866; their result has been either to leave the question open or, more polemically, to favor either birth order or mother's age as the major of two factors determining the incidence of twins. Recently, however, Dahlberg (24, pp. 28 ff.) has shown that, while the percentage of twin births climbs steadily up to the mother's age of thirty-nine, at any given age of the mother no reliable difference can be shown between the percentage of twins who are first-born and the percentage who are later-born.[4] Birth order, apart from age of the parent, thus appears to be ruled out as an effective agency in the determination of twins.

[4] A contrary finding in the report of the 1924 U. S. Birth Registration Area Statistics is discussed by Wilson and Jones (86) and considered to involve errors in the interpretation of a frequency table.

The birth weight of a child is an example of a trait in which mother's age and birth order have a joint, but unequal, influence. It is well established that earlier-born children are (at birth) inferior to the later-born in size and weight (Duncan, Hecker, Fasbender, Issmer, Harris, *et al.*, 46). In considering the gain in birth weight from the first to the sixth child, H. J. Hansen (40) believed that he was able to demonstrate that 28 per cent of this gain was due to the factor of mother's age, and 72 per cent to the number of previous pregnancies.[5]

The Effect of a Varying Sex Ratio. In a European population, in which both parents were of the same nationality, Little (55) has reported a ratio of males to females of 115.5 ± 1.5 for the first-born, and of 97.3 ± 1.86 for subsequent births. The difference is, of course, fully reliable. In a European "hybrid" population, however, the sex ratio was 121.2 ± 3.1 for the first birth order, and indistinguishably different (124.3 ± 2.9) for subsequent births. An inbred stock of laboratory rats yielded sex-ratio differences, in relation to birth order, which were strikingly similar to those in the first human sample. The possible significance of this factor becomes evident when we consider the magnitude of sex differences (*a*) in mortality-rate at the various ages, (*b*) in the incidence of specific diseases, and (*c*) in numerous physiological and social variables in development. While little attention has been paid to this matter in the past, it would seem desirable to base birth-order studies on the sexes taken separately, or at any rate to include sex-ratio figures in the data offered in description of the sample.

The Effect of Differential Mortality. It has long been known that still-births are more common among first-born than among second-born, although if the first-born are omitted, the stillbirth rate shows a steady increase in the successive birth numbers. This is indicated in the following table from the U. S. Birth Registration Area Statistics (82). While the difference between the first- and second-born seems sufficiently unequivocal, the rise in the later birth orders is undoubtedly affected by the factor of family size, which has not been eliminated in this material.

In addition to suffering from more frequent prenatal casualties,[6] the first-born are undoubtedly subject to a greater infant mortality than the

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[5]An interesting case of a non-hereditary and "non-cultural" trait, associated with birth order and mother's age, is given by Thurstone and Jenkins, from Sewall Wright (88). Four-toedness in guinea pigs is an abnormality which appears to be determined by unfavorable prenatal conditions. It occurs more frequently in the winter months, and more frequently among young mothers. There is also a pathological weighting of small families. That its primary dependence is upon mother's age and not upon birth order is shown by the fact that the correlation of $-.342 \pm .018$ between polydactyly and birth rank becomes reduced to zero when mother's age is held constant, but the correlation of $-.370 \pm .018$ between polydactyly and mother's age becomes $-.427$ with birth rank constant.

[6]In a sample of 286 cases in Berkeley, California, Jones and Hsiao (50) found an excess number of abortions, prematures, and over-term infants among the first-born, but an excess number of miscarriages among the second-born.

TABLE 2

STILLBIRTHS PER ONE HUNDRED LIVE BIRTHS—U. S. BIRTH REGISTRATION AREA

Order of birth	1924	1925	1926
1	4.3	3.9	4.0
2	3.0	2.3	2.3
3	3.1	2.4	2.4
4	3.4	2.9	2.9
5	3.9	3.2	3.2
6	4.2	3.4	3.5
7	4.7	3.7	3.9
8	5.0	4.2	4.6
9	5.8	4.7	4.6
10	6.2	5.4	5.3

second-born, as shown in Table 1.[7] As a result, it is certain that a study of infants will deal with a definitely more selected group of the first- than of second- or third-born. This selection, however, is subject to change during the preschool period, inasmuch as a relatively heavier death-rate is then found for the birth orders which escape with the clearest record at birth. This is also expressed in the data on child health, as reported by von der Velden (84). In his findings, the percentage of "healthy children" was 37 per cent or higher for first, fifth, and sixth birth orders, but in the neighborhood of 32 per cent for the second, third, and fourth orders. Concerning the disease record at still later ages, there is little to be said except with regard to tuberculosis, and here the literature is as confusing as it is voluminous. Numerous studies appear to attest a pathological weighting of the first-born with respect to tubercular tendencies, but, when allowance is made for size of family, incompleteness of family, and the ages of marked individuals,[8] the difference becomes slight.

On the basis of material collected over fifty years ago, Ansell (5) stated that, in spite of differential early mortality, the various birth orders became fairly well evened up by the age of forty-five. A number of studies have dealt with the comparative longevity of the various birth orders, but with flatly contradictory results (Redfield, Beeton and Pearson, Ploetz, Popenoe, Holmes and Wilson, 46). During the past two decade changes in the infant death-rate, which have been more marked in some groups than in others, have probably exerted a significant influence upon the relative survival of the various birth orders. Elderton (28) has presented the following very significant finding: In a British community the infant death-rate in a normal year was approximately 160; from the second to the sixth birth orders it was markedly smaller, about 100, rising to 140 after

[7]This finding is supported by Ansell, Elderton, Westergaard, Pearson, and Bolt (46). But Reiter and Ihlefeldt (64), on 763 children, reported the lowest rate of mortality for the first-born.

[8]A common error lies in the inclusion of a proportion of later-born siblings who are not old enough to have manifested a tendency to tuberculosis, if it is present. Hence the later-born may be regarded as showing a "lower degree of susceptibility" when the primary factor is immaturity.

the tenth birth. During the year of an infant epidemic, the first birth order was affected only slightly, the intermediate orders were brought up close to the rate of the first orders, while the rates for the later orders were enormously increased, reaching 300. Involved in this we have, of course, the factors of infant care and of preventive hygiene, which are notably poorer in larger families. When a group of mothers with "good health and habits" was selected, the reduction of the birth-rate was much less marked for the first-born than for later-born. This suggests, in other words, that primiparous offspring suffer a handicap in viability which is determined chiefly by prenatal factors, and that this handicap is (relative to the other birth orders) little subject to either increase or decrease by external conditions. It cannot be inferred that Elderton's results are widely applicable, but the principal bearing of this discussion is upon the very point of limited applicability of samples. Psychological differences within the various birth orders have, as a rule, been small in magnitude, and they have not always been in the same direction in different samples. Even where our selection is fully adequate for a living population, differential death-rates, which vary and reverse themselves with age, and which show markedly different responses to economic and social changes, may be responsible for differences in the character of surviving samples. For such factors statistical corrections cannot readily be applied, but their recognition may aid us in interpreting discrepant findings.[9]

The Effect of Changing Birth-Rate. In groups of different ages if we determine the percentage of feebleminded who are first-born, we shall no doubt find that, even with identical criteria for classification, this percentage will vary according to the average age of the population considered; if the general birth-rate is diminishing, the percentage of first-born in *any* category will be higher among the younger groups.

If the diminishing birth-rate involves an increase in the average natal interval, this will also magnify the probability of marking the earlier-born, even if we are careful to restrict our study to families of a constant size. For, with an increasing natal interval, we encounter more and more later-born who fall below the age at which the "marked" condition (such as delinquency, or school retardation) can be competently recognized. This may be particularly important if we attempt to compare data in populations of similar social status but of differing dates of birth.

If a falling birth-rate is due to a later age of marriage and the establishment of fewer families, this will have the peculiar consequence of *reducing* the proportion of earlier-born among children of a given age in families of a given size. Suppose, for example, we wish to study the incidence of

[9]The following example may be cited: Among over four thousand Oakland school children, Boas (10) was able to demonstrate a significantly greater height and weight for the earlier-born. The differences between the birth orders, in Boas' results, are probably induced by factors associated with family size. But the marked contrast with the findings for neonates (who show an inferior weight and length for the first-born) is no doubt partly traceable to the effects of selective mortality.

certain neuropathic conditions, at puberty, in families of two, three, and four children. Since the diminishing rate of birth implies that each year fewer children are born who belong to the earlier birth numbers, unless we allow for this factor our study will result in a spurious weighting of the later-born.

The various disturbing factors listed above are by no means the only ones which have led astray investigators in this field, but the catalogue is already sufficiently long to indicate the chief pitfalls, and the treacherously complex character of our problem.

The Prenatal and Neonatal Handicapping of the First-Born

It is not within the scope of this chapter to review the very extensive literature on physical traits in relation to birth order. Certain points, however, deserve to be mentioned in connection with the problem of the physical handicapping of the first-born. These handicaps are perhaps as a rule of slight duration, but it is conceivable that they may in some cases have far-reaching effects upon the general development of the child.

1. Prenatal conditions are said to be less favorable for primiparous mothers, with a tendency to uncommonly severe toxemias and other disturbances of pregnancy. It is not well established, however, that this is an important differential factor except at the extremes of the child-bearing period. In an investigation of mothers' reports and medical records for 310 pairs of pregnancies, in the first three pregnancies, Jones and Hsiao (50) found no evidence of a relationship between pregnancy order and the health of the pregnant mother. It was suggested that contrary views concerning the first pregnancy are probably influenced by data from single-pregnancy families.

2. The first-born show a higher percentage of prematures (50). While we know that prematures may develop quite normally, they are liable to a social as well as to a physiological handicap. The requirement, at any period of growth, of an exceptional degree of care and solicitude may not be a favorable factor in the development of normal parent-child relationships. The numbers of cases influenced by such factors are, however, so few that they could hardly have a sensible effect upon trait differences between groups of first- and later-born.

3. The duration of labor is approximately 50 per cent longer for primiparae than for multiparae (Williams, 84*d*). According to DeLee (25*a*), the incidence of eclampsia is three times as great in the first as in later pregnancies. Elderton (28) has reported that the percentage of abnormal confinements drops from 22 per cent for the first-born to 14 per cent for the second-born and to 8 per cent for the third- and fourth-born, increasing somewhat thereafter. According to Jones and Hsiao (50), the chief differentiating factor in this connection is instrumental birth, which they found to occur in 18.5 per cent of first pregnancies, while for the same mothers the percentage was only 8.4 in the second pregnancy. Wetterdal (84*b*), however, has reported that for children

surviving into school age there was no relationship between their physical robustness at that time and instrumental or non-instrumental birth. The developmental significance of this factor is probably limited chiefly to the less common types of instrumental delivery (high forceps).

4. The first-born are on the average smaller and lighter at birth than the later-born [see Hsiao (46) for a review of the literature on this topic]. The difference, however, may be attributable to a shorter average pregnancy for the first child, rather than to any significant biological inferiority. There is good evidence that physiological weight loss, following birth, is more rapid among the first-born (Adair and Stewart, 3) and recovery is slower (Kézmárszky, 52). These difficulties in early nutritional adjustments appear to occur independently of the factor of breast-feeding. Jones and Hsiao (50) have made a study, from mother's reports, of the neonatal condition of their children and of the child's health during the first year. Among approximately three hundred pairs of first and second children, neonatal condition was reported as better for the first-born in 6 per cent, and for the second-born in 14 per cent; health during the first year was reported as better for the first-born in 17 per cent and for the second-born in 18 per cent.

5. The first-born are reported to have "less participation in the blessings of the mother's breast" (Schlesinger, 68). From a psychoanalytic viewpoint, it is perhaps hard to say whether this is likely to involve a greater or less degree of "weaning trauma" (Bernfeld, 8). In a study of siblings, Jones and Hsiao (50) were unable to confirm previous findings with regard to duration of breast-feeding, the first, second, and third birth numbers showing no reliable differences. The outstanding fact about this sample was the predominance of families in which birth-order differences in physiological measures were absent or too slight to report, although the usual differences were found in physical size in favor of the later-born. A number of writers have, no doubt, been too ready to magnify physical handicaps, where they occur, and to assume that they necessarily predispose some form of permanent defect. Since actual developmental studies in this field are not yet available in quantitatively adequate form, we may now turn to the direct comparisons of the various birth orders in psychological traits.

Birth-Order Differences in Intelligence

In surveying the psychological data on differences between the various birth orders, we find that the greatest persistence in inquiry, and the most careful quantitative measurement, has occurred in connection with intelligence. Earlier studies in this field were concerned with the incidence of mental defect, or of mental superiority, considered as ungraded entities. Later work has dealt primarily with the comparison of siblings in degrees of intelligence as measured by tests.

In studies of mental defect, it is necessary to distinguish between Mongolism and defect due to primary or to other secondary sources. Whatever

may be the developmental causes of Mongolism, it is fairly clearly established that Mongolians occur more frequently among the last-born. In the largest collection of cases in the literature (583, in families of two or more), Brousseau and Brainerd (15, pp. 30-31) report an incidence of 57 per cent in the last birth position. Van der Scheer (83) has shown that the ratio of observed to expected, among Mongolian births, is particularly heavy after the fifth birth order; he also reports the interesting finding that among mothers over forty the average interval between normal births is 2.8 years, but in the case of the birth of Mongolians the average interval since the last birth is 4 years, with an enormous pathological weighting for intervals of 9 years or more. Thurstone has concluded that the term "*Spätling*" may be properly applied to the Mongol because of his tendency to occur as the last-born, as the last-born among older mothers, as the last in a long series of births, and as the last after a long interval of no living births. Apparently no tabulations have been made of the percentage of Mongolians for each age of mother and for each birth order separately. Until this is done, it is difficult to estimate the relative importance of these two factors in determining Mongolism. It is possible, moreover, that the actual incidence of Mongols among the last-born is exaggerated through the inclusion of some incomplete families; doubtless the "natural" incidence would also be lower if the birth of a Mongolian were not followed by voluntary restriction of later pregnancies.

The earlier studies of Mitchell (59) and Down (26), indicating a higher percentage of mental defect among the first-born, agree in general with the results of later, more comprehensive investigations by Hansen (41), Pearson (63), and Kuhlmann (54). Among approximately 1200 feebleminded, Turner and Penrose (81*a*) found no significant birth-order difference in the total group, comparing actual incidence with estimated incidence based on chance. But when the group was classified into three grades of mental defect (physicians' records), the lowest grade showed a heavier weighting among the first-born. The number of cases in this subgroup is too small for reliability. Rivers (65) reports some evidence that mental defect falls least heavily among the middle children in the family. Dayton (25), however, asserts that it is precisely among the middle children that the highest percentage of defectives is found. In view of such conflicting results, it seems necessary, for the present, to suspend judgment. It may be pointed out that studies which find an excess of defectives among the first-born have in some cases failed to allow for the fact of family size; as was noted on a previous page, extreme defect tends to occur in small families, and hence a pathological weighting of the earlier-born may be due to the failure of certain very inferior stocks to average more than one or two children. Another difficulty in the interpretation of this material lies in the possibility of incomplete families; in a given family the first-born may more frequently be labeled defective, because there has been a greater opportunity, over a longer period, for society to recognize this condition. Moreover, first-born children are the

offspring of younger mothers, and it is possible that, if mothers under twenty were eliminated (as in the material of Hansen and of Pearson), the first-born would occupy a more favorable position.[10] The most recent study of this character, and the only one based upon objective tests, is that of Dayton (25) on 10,455 retarded children in the public schools of Massachusetts. Although the schools should contain an accumulation of older defective children, there is no clear-cut evidence that in families of a given size the first-born, or the last-born, provide an excess percentage of marked individuals. On the other hand, in large families a definitely higher frequency appears to occur among the middle children. Thurstone and Jenkins (80) criticize, and with some justification, this selection of cases from a public-school enrollment. Particularly in the instance of large families, the later-born may be of preschool age, while the earlier-born have passed beyond school; this would necessarily result in a weighting of the middle birth orders. One further comparison is possible from Dayton's tables: the ratio of defective (below 70 IQ) to retarded individuals (above 70 IQ) in each birth order. This ratio is highest for the first-born—a fact which Dayton ignores, which Thurstone and Jenkins attribute to an inferiority of the first-born, and which the present writer is inclined to attribute to scale inequalities that throw an excess proportion of the older children below the arbitrary boundary line of mental deficiency.

Recently Brugger (15*a*), in a study of 819 feebleminded in 488 families, has reported that the distribution of feebleminded in the various birth orders follows closely the expected number of cases (as estimated by Weinberg's method). He found, further, that the birth sequence of feebleminded in a sibship followed the laws of probability. There was no tendency beyond chance for the feebleminded to occur consecutively, as would be expected if certain series of birth positions were pathologically weighted.

If confusion attends our interpretation of the incidence of mental defect, the problem is hardly less involved when we turn to a consideration of the incidence of superior ability. In judging ability by achievement, it is obvious that the age factor is of importance, and that in a given family the earlier-born will exceed the later-born in the years of opportunity for reaching distinction. Galton (34), in a study of English men of science, and Gini (36), in an incompletely recorded study of Italian university professors, find a preferential weighting for the first-born. Havelock Ellis (29) is the author of a well-known study dealing with 1030 British men and women of eminence; in selecting this group he employed the criterion of "3 or more pages in the *Dictionary of National Biography.*" Ellis' results are summarized in our Table 3. In this table it is shown that the observed proportion of eldest is greater than the expected propor-

[10]Pearson's data on imbecility are based on cases marked through admission to a custodial institution; they show a significant excess of the first-born only when families of all sizes are considered together. In families of any given size, the birth-order differences are of a much less conspicuous character. The data reported by Hansen, and by Kuhlmann, are too incomplete for a critical interpretation.

TABLE 3

PERCENTAGES OF EMINENT OFFSPRING OCCURRING AS FIRST-BORN AND LAST-BORN*

Family size	Expected	Observed Oldest	Observed Youngest
2	50.0	56	44
3	33.3	47	34
4	25.0	35	9
5	20.0	29	20
6	16.7	24	17
7	14.3	44	15
8	12.5	9	18
9	11.1	42	21
10	10.0	28	16

*Computed by the writer from Ellis' data.

tion in nearly every size of family. In spite of competition with a much larger number of intermediates in families of nine or ten, nearly as high a percentage of eldest become distinguished as in families of only two or three. With respect to the youngest, we find that for the smaller families they correspond closely to expectation, but that in families of eight or more they definitely exceed expectation, and this becomes even more conspicuous in the still larger families (beyond ten), which are not shown in this table because of the small number of cases. Ellis concludes:

> "It would appear that there is a special liability for eldest and youngest children to be born with intellectual aptitudes, the liability being greater in the case of the eldest than of the youngest. It may be added that if we were to take into consideration the survivors of a family only (the net fertility) the youngest children would occupy a still more conspicuous position."

In agreement with Ellis, Ogburn[11] is reported as finding the oldest child most frequently represented in *Who's Who in America,* the youngest child next most frequently represented, and the middle children less frequently.

The most impressive body of evidence in this field is that to be derived from a comparison of Terman's (78, pp. 121-125) data on gifted children with Cattell's (20) on American men of science. Table 4 presents the percentages of birth (gifted children) of each order for families of two, three, or four children. Cattell's figures for American men of science are given in parentheses.

Terman writes:

> "There is a very striking agreement between Cattell's data and our own for families of two children. In each case nearly three-fifths are first born. The agreement is only moderately close for families of three and four children, which may be explained on the hypothesis that first born gifted in families of three or four children were more likely to have been missed because they had advanced beyond the

[11]Quoted by Thurstone and Jenkins (80) from unpublished material.

TABLE 4

PERCENTAGES OF GIFTED CHILDREN AND OF AMERICAN MEN OF SCIENCE IN EACH BIRTH ORDER FOR EACH SIZE OF FAMILY

Size of family	Birth order First	Second	Third	Fourth
2	56.1 (57.4)	43.9 (42.6)		
3	36.9 (44.0)	31.9 (31.2)	31.2 (24.8)	
4	33.0 (36.1)	26.8 (22.4)	15.4 (21.8)	24.7 (19.7)

eighth grade. It has been suggested that the better chance which the first born apparently has of becoming a leading man of science may be due to greater educational opportunities enjoyed by the first born. This alleged educational advantage is, of course, hypothetical but, even if it were actual, one might very well doubt whether the effect would register in the Binet IQ to almost exactly the same degree as in scientific performance, especially since the IQ's were taken in childhood, while the supposed influence of environment upon scientific performance would presumably depend chiefly on the relative amount of schooling enjoyed by first born and later born *after* the years of childhood. Such facts seem to render the environment hypothesis very questionable."

However, Terman points out the possibility of a selective factor due to the use of a limited age range and of incomplete families, while Cattell, who inclines to a social explanation of his findings, considers that his data may be vitiated by the factor of age and by the possibility that some individuals who consider themselves first-born may have neglected earlier siblings dying at birth or in infancy. Of course there has been no attempt, in this material, to base the classification upon pregnancy order (taking account of abortions and miscarriages). The consensus of evidence, in the studies reported above, suggests a greater variability of the first-born; as compared with middle children, and, to a less degree, as compared with the youngest, the first-born appear to carry a greater predisposition toward mental defect and also toward unusual superiority. However, before psychologists become too greatly concerned about the explanation of these results they should attempt to place the facts themselves upon a more assured basis.

We may now turn to the data on intelligence, based upon a comparison of quantitative test scores in the various birth orders.

In 1923 Mallory (56*a*) reported measurements of 394 school children (test instrument not specified). For the first five birth orders he obtained average quotients of 103, 98, 106, 107, and 102, respectively. Although he concluded that intelligence is affected by birth order, it is apparent from these data that the averages represent chance fluctuations.

In the following year, Crump (23*b*) conducted a study based on a careful sampling in several communities. For 781 school children, average IQ's (Illinois General Intelligence Tests) were close to 90 in each of the first four birth orders. In the subsequent orders the average IQ ranged from 94 to 104, but without evidencing a systematic trend. For children of older parents Crump reported a higher average IQ (103) than for children of younger parents (98). She considered this to be in agreement with the theory that intelligence increases with order of birth, due to biological changes associated with the age of the mother. It is probable, however, that the biological factor enters chiefly in connection with selection, a positive correlation having been demonstrated [see, for example, Conrad and Jones (23*a*)] between the intelligence of the mother and her age at the birth of the first child.

The first study involving siblings is that of Willis (85), who compared 219 pairs of first and second children tested by the Stanford Revision (ages not stated). A small reliable difference was found in favor of the second child (4.5 ± 1.16). It will be shown in a later part of this chapter that such a difference can be attributed to a negative correlation between Stanford IQ and chronological age. Willis considered that his results were in harmony with the belief that a disproportionate number of feeble-minded occur among the first-born; an excess of first-born could be due to the eldest in families in which the younger siblings were merely "borderline" or "backward." As a matter of fact, however, Willis' results lend support to no theory except that of an equality of first- and second-born. A correction for the age factor would almost certainly eliminate the small difference which he found.

The study of Sutherland and Thomson has already been mentioned. Here a slight tendency was found for the elder to be more intelligent, but the negative correlation between IQ and birth order ($-.200 \pm .019$) was reduced nearly to zero when the factor of family size was held constant. Their data contain no evidence for an influence of birth order upon IQ.

As a starting-point for a study in certain Minnesota schools, Arthur (6) observed that "an inspection of the school system as a whole had given the general impression that the younger members of foreign families were better stuff both mentally and physically than the elder siblings." The Kuhlmann-Binet was given to 245 pairs of first- and second-born siblings from families of foreign surnames. The elder siblings averaged 88 IQ, the younger 96. In 85 three-child families, a progressive increase in IQ was shown with birth order (82, 90, 95). Arthur has concluded that (*a*) the difference cannot be accounted for in terms of scale inequality, since it is maintained among siblings with a natal interval of only two years, or less; (*b*) it is not due to a coaching of the younger by the older child, since it is maintained in those cases in which the younger child was tested first; (*c*) it is not due to a language factor, since the difference increases with age; (*d*) it is peculiar to families which are undergoing a social transition, since it is small or absent in fully Americanized

families. She suggests that we may look for causal factors in (*a*) physiological changes in parents, resulting from a radical change in their environment, or (*b*) differential effects upon the children of the preschool environment, which may afford better physiological or better social conditions for the later-born.

As this was the first careful study of the kind, Arthur's report received wide attention. Several criticisms, however, may be offered with regard to her results: (*a*) The possible influence of scale inequality has not been completely met, for a difference as little as two years may, in a fully homogeneous sampling, yield a distinct reduction in IQ (Jones, 48; Hirsch, 44, p. 201). Inadequate reliability attaches to subdivisions of her sample, in which a smaller age difference occurred.[12] (*b*) In comparing siblings in kindergarten and the early grades, a higher proportion of the second-born will be found in the kindergarten. This involves the presumption of a very serious sampling error unless it can be shown that the kindergarten draws a selection of children which is fully comparable to the compulsory enrollment in the grades. In a study of 2200 cases in the kindergartens and first two grades of Berkeley, California, Jones and Hsiao (49) showed a steady drop in mean IQ from 113.6 in children of five and a half years to 102.7 in children of seven and a half years. This was imputed chiefly to a selective factor, involving a negative correlation between IQ and age at entering school; in such a population, a spurious weighting is certain to occur against the elder-born. (*c*) A portion of the sibling pairs was selected on the basis of behavior or scholastic problems arising among the first-born in the grades. The investigator commented:

> "But even though the elder sibling should be referred for testing because of some school difficulty, there seems to be no clear reason why the sibling in kindergarten or first grade should not be just as dull or more so instead of brighter, as he seems to be."

This neglects, however, the principle of regression to the mean; in a trait which is influenced by hereditary factors, *relatives* of marked cases will, on the average, fall closer to the mean than those cases which are marked on the basis of deviation from the mean.

Another instance of an apparent birth-order difference which falls under suspicion when more closely examined occurs in a study by Commins (23) of 142 pairs of siblings in Grades 3 to 8. On the McCall Multi-Mental Test, the younger sibling was superior in 70 per cent of the cases, but it was found that on this test nine-year-olds obtained an average IQ of 115, and fourteen-year-olds an IQ of only 97.5. Although he did not attempt a correction for this factor, Commins recognized that the inferiority of the earlier-born (and elder) siblings was largely an artifact of the instrument of measurement.

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[12]Among preschool children, Mohr and Bartelme (60) have found on the Kuhlmann-Binet a correlation of $-.34 \pm .056$ between IQ and CA. If a similar negative correlation exists within Arthur's age range, it would fully account for the birth-order differences in the main sample.

McFadden (58) has reported National Intelligence Test data for 74 sibling pairs who show no intelligence differences, and Stanford-Binet data for 126 sibling pairs who show a reliable inferiority of the first-born (74.2 as compared with 79.6 IQ). His group, however, was extremely heterogeneous, including "children from superior schools, backward pupils, problem cases, defectives, and institution cases." From a sample of this character, with no possible appraisal or control of the conditions of selection, it is scarcely permissible to draw conclusions concerning the problem in hand. No adjustments were made for inequalities in the measuring instrument.

A number of investigations have been made of the intelligence of only as compared with non-only children. Such data are not directly relevant to the birth-order problem, since only-child families may involve a social selection which is difficult to control. Ward (84*a*), Guilford and Worcester (39*a*), and Blonsky (9*a*) reported a higher IQ for only children. Kinser (52*a*), on the other hand, with a much larger number of cases than the foregoing, found no difference between only and other children. These divergent results can be interpreted in the light of a report by Conrad and Jones (23*a*) in which they discuss the differential birth-rate as a function of social conditions. Kinser's data are derived from a relatively stabilized American community in which the restriction of family size to one-child families has apparently become non-differential with reference to social status.

We come now to three studies which attempt a statistical correction for scale inequalities through the conversion of mental ages or test scores into standard scores at each age. In the first of these studies, by Jones and Hsiao, the standard scores were based upon the age means and standard deviations of the actual sibling population; no intelligence differences were found in relation to birth order. In the remaining two studies, by Thurstone and Jenkins, and by Steckel, the compared siblings were a subsample of a larger population upon which the standard scores were based; these latter studies agreed in assigning a lower intelligence to the elder siblings.

Jones and Hsiao (49) dealt with 614 pairs of siblings obtained in a study of rural families in an unselected sample which was based (without regard to school enrollment) on the total population of a group of isolated communities. To quote from this report:

> "Due to exclusively native origin, no foreign language handicap was present in any of these families; no conditions of marked poverty were encountered, and the range in social status was restricted for the most part to the interval from 5 to 10 on the Barr scale. It may be noted also that in these communities the general economic and social conditions are stable and slow to change, so that the successive children of a family develop under more comparable environmental conditions than is usually the case in urban centers. The Stanford-Binet test was used to the age of 14, and the Army Alpha (Forms 5 and 7) from 10 years upwards. Each mental age and Alpha point score was translated into a Sigma index, dividing

TABLE 5

THE INTELLIGENCE OF ELDER COMPARED WITH YOUNGER SIBLINGS

	Adjacent pairs	Non-adjacent pairs	Total
Number of pairs	330	284	614
Mean difference (elder-younger)	—.010	—.055	—.030
Median difference	+.035	—.058	—.003
S.D. of distribution of the sib differences	1.0835	1.070	1.075

> the deviation from the age median by the S.D. for that age. In this group of comparable scores, the pair differences were computed for pairs adjacent in birth order and for non-adjacent (non-successive) pairs."

The differences in Table 5 are, of course, insignificant. In variability, as well as in central tendency, this study showed a close equality between the earlier- and later-born.

The investigations by Thurstone and Jenkins (79) and by Steckel (72), under Professor Thurstone's direction, may be considered together; similar methods were employed, but with very different samples. The first of these dealt with a group of clinic cases, drawn from a ten-year assemblage of records at the Institute for Juvenile Research in Chicago. The age range of this population is from the preschool period to twenty-one years; the mean IQ falls in the borderline area between 70 and 80. Nearly 400 families were available for the comparison of first and second siblings, and somewhat smaller numbers for comparisons among the other birth orders. The procedure involved the use of Stanford-Binet IQ's, with a subsequent check in terms of standard scores based on a larger Institute group; while details were not given, it was stated that with the use of these standard scores the results were unchanged. In the second investigation, 2712 families were included, composed of siblings tested in the public schools of Sioux City, Iowa, over a three-year period. In the appropriate grades, the tests used were the Kuhlmann-Anderson, National Intelligence Test, Otis

TABLE 6

MEAN IQ ABOVE FIRST-BORN CHILD

Order of birth	Thurstone-Jenkins	Steckel*
1	0.00	0.00
2	3.11	1.26
3	4.87	3.22
4	8.05	5.46
5	11.28	6.44
6	8.43	8.12
7	10.87	10.50
8	17.42†	12.18

*The figures in this column were computed by the writer, on the basis of a constant *S.D.* of 14; as the *S.D.*'s actually varied from 13 to 15, a reference to Steckel's original data would probably show slight modifications in the figures.

†Eighth or later birth order.

Intermediate, and Otis Advanced. The age range was from five to twenty-one years. Results were transmuted into standard scores, based on the age means and variability of approximately 20,000 children in the total school enrollment.

In order to make full use of the data, the comparisons between the various birth orders were written down in the form of observation equations, and the best-fitting increments in IQ's were determined by the method of least squares. Taking the first birth order as an arbitrary origin, these increments were as shown in Table 6.

Thurstone concludes:

> "The inference seems natural here that on the whole the later born siblings tend to be on the average brighter than the first born. Not only does this seem to be the case in the comparison of first born with the subsequent children, but the rise in intelligence with order of birth seems to continue as far as the eighth born child."

Without favoring any of these hypotheses, he mentions a number of possible explanations of such an effect, in terms of (*a*) more adequate maternal experience in rearing later children, (*b*) progressive improvement in economic status of families, (*c*) more favorable social opportunities for the later-born, particularly in learning to talk, and (*d*) some physiological effect in the mother which favors, progressively, the later-born children. These two studies deserve very careful consideration. Compared with all previous work, they are outstanding in the number of cases represented, and in the thoroughness of the statistical analysis. Their results are closely similar, but are in disagreement with the conclusions which must be assigned to other investigations in this field.

Attention has already been directed to the fact that in these two studies the method of eliminating scale inequalities was to convert mental ages or raw test scores into standard scores on the basis of a main sample. This method should correct all spurious IQ fluctuations attributable to chronological age, providing the main sample is strictly comparable to the subsample. Since the subsample is composed of siblings, it should represent a fairly constant selection at all ages; any selective trend in the successive age groups of the main sample would necessarily be reduced when we restrict our cases to siblings. Although full information is lacking on this point, it seems almost certain that in Steckel's public-school group, extending through high school, a selection has occurred in the upper ages. It is reasonable to inquire whether a similar selection has also occurred in the clinic group. To the extent that such factors are operative, the negative correlation between age and IQ would, in the main samples, be counteracted by the effects of selection. But in the subsamples this negative correlation would remain, and would be uncorrected by the use of standard scores derived from the larger, but more selected group. To illustrate this point, assume that in a total school enrollment the average IQ is 100 at ages twelve and eighteen, with an *S.D.* of 15. Assume that in a fully

unselected population (on the basis of families, and not on the basis of school enrollment) the IQ drops from 100 at age twelve to 85 at age eighteen, due solely to defects in scale construction or standardization. Then the later-born who are aged twelve would average 1 *S.D.* superior to the earlier-born who are aged eighteen, and this spurious difference would remain after the IQ's, or their equivalent mental ages, are converted into standard deviation scores on the basis of the distributions in the total school enrollment.

Hsiao (46, Chap. 4) has employed a different method of correcting for scale inequalities through the use of the regression of IQ on CA. His sample included a total of 2127 cases from the school systems of Berkeley and Oakland, and consisted of two main divisions: pairs of first- and second-born siblings, and "singles," consisting of the first- and second-born from different families. Results are available on three tests, the Stanford-Binet, the Terman Group, and the National Intelligence Test. In addition to the main groups of cases which were taken from the routine school records, an experimental group of 100 pairs of siblings was tested by the abbreviated form of Stanford-Binet, with special attention to obtaining a purely unselected sample. Table 7 gives a comparison of IQ's for the pairs of siblings, tabulated by tests.

These figures appear to be in close agreement with those of Steckel, and Thurstone and Jenkins, in denoting a slight inferiority of the first-born. For the group tests, the average difference between the first- and second-born is 2.4, as compared with 1.26 as found by Steckel. For the Stanford-Binet, the average difference is 3.4, as compared with 3.11 reported by Thurstone and Jenkins. Before basing conclusions on these results, however, consideration should be given to the data in Table 8.

As indicated by the data in the table, the Stanford-Binet records were derived chiefly from children in the kindergarten and in the early elementary grades, with an average age of between seven and eight years; the National Intelligence Test sample shows an average age of about ten years,

TABLE 7
A COMPARISON OF IQ'S OF THE FIRST- AND SECOND-BORN
(After Hsiao)

Test	*N*	Birth order	Mean IQ's	Sibling correlation (single entry)	Chances in 100 that the first-born are inferior
Stanford-	133	1	102.8 ± 1.3	.56	100
Binet	133	2	107.6 ± 1.3		
Stanford-	100	1	107.5 ± 1.3	.35	86
Binet (short scale)	100	2	109.1 ± 1.2		
Terman	183	1	107.6 ± 1.0	.52	93
Group	183	2	109.0 ± 1.0		
National	118	1	102.1 ± 1.3	.39	99
Intelligence Test	118	2	106.2 ± 1.4		

TABLE 8

THE CORRELATION OF AGE AND IQ FOR EACH TEST AND EACH BIRTH ORDER

Test	Birth order	Mean age	$r_{\text{CA-IQ}}$
Stanford-Binet	1	99.3±2.1	—.29±.054
	2	80.9±1.6	—.31±.053
Stanford-Binet	1	110.0±1.9	—.20±.074
(short scale)	2	89.5±1.9	—.23±.064
National Intelligence Test	1	123.8±1.6	—.35±.055
	2	117.4±1.2	—.36±.054
Terman Group	1	171.5±1.3	—.31±.045
	2	156.4±1.3	—.49±.038

and the Terman Group Test sample consists largely of junior-high-school pupils, with an average age of fourteen. The outstanding fact about these figures, however, is the difference in the ages of the first- and second-born; such a difference would no doubt be expected in any assembly of sibling pairs in a clinic or in a school unless unique precautions are taken to test all children at exactly the same age. The consequence of this age difference is to handicap the elder child if scale inequalities involve a tendency for IQ's to diminish with chronological age. Such a tendency is very clearly shown in the last column of Table 8. The correlation between CA and IQ is of the order of —.3; except for one aberrantly high figure in the Terman Group Test, it is fairly consistent in the various ages and tests and in each birth order.

The foregoing results cannot be due to a sampling selection on the basis of age, for in these schools such selection would hardly begin to show a significant influence before senior high school, and, in any event, its usual effect would probably be to produce a positive rather than a negative correlation between CA and IQ. We must conclude that the apparent handicap of the first-born in these samples is due, at least in part, (*a*) to the fact that the first-born, when tested, naturally tend to be older than the second-born, and (*b*) to the fact that older subjects tend to achieve lower IQ's through defects in scale construction and standardization; one cause of such a defect would be the use of school children from a slightly superior rather than from a genuinely representative sample in the upper ages.[13]

It is possible to correct for the factor of scale inequality (or for supplemental errors of sampling which may counterfeit scale inequality) by the use of the following formulae:

$$IQ_{A1} = IQ_1 + (CA_2 - CA_1)\left(r_{CA_1\,IQ_1}\frac{\sigma_{IQ_1}}{\sigma_{CA_1}}\right)$$

[13]The spurious fall of IQ with age, in a sample equally unselected at all ages, is by no means a new finding, although it has been accorded relatively little attention in the literature.

$$IQ_{A2} = IQ_2 + (CA_2 - CA_1)\left(r_{CA_2 IQ_2}\frac{\sigma_{IQ_2}}{\sigma_{CA_2}}\right)$$

Hsiao's original tables present a comparison of the adjusted IQ of the first birth order (IQ_{A1}) by the original IQ of the second (IQ_2), and also of the original IQ of the first (IQ_1) by the adjusted IQ of the second (IQ_{A2}).

Table 9 (computed by the writer from Hsiao's data) gives the averaged results from these two types of comparison. As a result of this necessary procedure of correction, the second-born have definitely lost their "superior" status, and the conclusions and general implications must be very different from those which might be drawn from the uncorrected data. Similar results were obtained when the raw and the adjusted IQ's were determined for 827 "singles" (first- and second-born in sibships in which only one member of the sibship was tested).

In the most recent study in this field (Jones and Kinser, 51*a*) the age factor was controlled by restricting comparisons to children of the same age; using this method, raw test scores or mental ages could then be compared without correction or conversion into other measures. The factor of social status was controlled by restriction to families of a given size. Table 10 is based on 739 cases from complete families, tested as a representative cross-section of all H8 children in the Oakland schools; it was

TABLE 9

A Comparison of the First and Second Birth Orders after Correction for the Age Factor

Test	Number of pairs	Mean IQ of first-born	Mean IQ of second-born
Stanford-Binet	133	104.5	105.2
Stanford-Binet (short scale)	100	108.9	107.5
National Intelligence Test	118	109.1	106.4
Terman Group	183	103.0	104.9
Total	534	105.82	105.79

TABLE 10

Terman Group Test Means for Groups of a Given Age and Family Size

Family size	Birth rank	Age 13-0 to 13-11 N	Age 13-0 to 13-11 Mean score	Age 14-0 to 14-11 N	Age 14-0 to 14-11 Mean score
Two	1	103	106.1±2.1	82	86.0±2.7
	2	102	104.5±2.0	71	81.9±2.7
Three	1	30	102.1±3.7	35	82.5±3.4
	2	44	101.8±3.1	47	70.2±2.9
	3	50	99.6±2.7	42	80.6±2.9
Four	1	5	91.2	11	76.2±4.4
	2	13	95.9±4.7	20	74.6±4.5
	3	25	104.0±3.5	20	80.7±4.5
	4	19	102.0±3.9	20	85.1±5.8

found that the addition of cases from possibly incomplete families (children with younger siblings under six) produced no significant change in the group means. It was also found that within a given age group the actual average ages for each birth order were identical within fractional parts of a month. In Table 10 there are no reliable differences between the birth orders. The consistent slight superiority of the first-born, in families of two and three, could readily be due to chance, and is not repeated in families of four. The foregoing negative results were confirmed by a correlational analysis of the total grade population. For 1354 cases (age 11-6 and 18-3, and family size 1-11) the partial correlation for intelligence and birth order, with age and family size held constant, was $.009 \pm .018$.

We conclude that intelligence is not proved to be a variant with order of birth. Such a negative finding is in accord with expectation if individual differences in intelligence are determined chiefly by genetic rather than epigenetic factors. Later studies may succeed in demonstrating a birth-order difference in special groups; as hypotheses for further research, attention is called particularly to the possibility that a pathological weighting may attach to the offspring of very young mothers, to the first offspring of older mothers, to the first-born after a series of abnormal pregnancies, to children born after very short natal intervals, and to the late birth orders in large families. There is greater promise, however, of positive results in connection with traits which other studies have indicated to be more readily subject to environmental modification.

Birth-Order Differences in Other Traits

Language Development. As a possible source of superiority in the later-born, it has been suggested that the younger children may have an advantage in the acquisition of language. Such seems to be the case in biographical reports of siblings by Stern (73), Gale (32), and several others. But M. E. Smith (71) gives references to nearly as large a number of investigators who found the older child more precocious in language development, when records were compared for siblings observed at the same ages. Abt, Adler, and Bartelme (2), in a study of one thousand clinic cases, have reported zero correlations between birth order and the age of beginning to talk ($.03 \pm .03$ for boys, $.00 \pm .03$ for girls). For each sex, the range in the age of "beginning to talk" was from six to sixty months. In view of the abnormal character of the sample, it is possible that actual differences in beginning to talk may be obscured by other factors, and particularly by the unreliability of the mothers' reports. In a normal sample of Berkeley families, Jones and Hsiao (50) have approached the same problem by a somewhat different method of data collection. It was thought that comparisons of siblings in terms of "earlier" or "later" in the acquisition of a functional vocabulary could be more reliably made by the mother than an estimate of the actual month of beginning to talk. The results, for 171 pairs of siblings in the first

three birth orders, indicated the presence of intra-pair differences in about two-thirds of the cases, but these differences favored the older as often as the younger sibling.

A further negative finding in this field has been reported by Smith (71), who gave a vocabulary test to twenty-eight pairs of children between the ages of two and six. The pairs were not siblings, but were matched on the basis of chronological and mental age; this method, which is new in birth-order studies, is capable of controlling most of the factors associated with age, social status, and family size. The average vocabulary for the first-born was 1738 words, for the second-born, 1744.

School Achievement. Mallory (56*a*) and Crump (23*b*) have reported achievement-test results in relation to birth order, but without controlling social status. Their tables, for a total of about one thousand children, agree in finding the first-born superior to the second-born; there are, however, no systematic trends in their material, and (contrary to their conclusions) it is probable that sampling factors account for the obtained differences.

Hsiao (46, Chap. 4) made a study of 427 pairs of first and second sibs with reference to their grade position in the first eight grades of school. Relative to age, the first-born were significantly more retarded in school than the second-born, but this greater retardation was shown to be due (*a*) to the fact that the first-born averaged two and a half years older and (*b*) to the existence of a cumulative degree of retardation within each birth order. When a correction was made for this age factor, the apparent inferiority of the elder children was eliminated.

In families of two children Busemann (17) found no significant difference in school rank between the first-born and the second-born. In larger families, a slight tendency was reported for the earlier-born to be superior to the later-born (total cases, 400). A further outcome of considerable interest was that the highest average ranks were obtained by children in sexually homogeneous sibships. Scholarship was found to diminish progressively according to the number of opposite-sexed siblings in a child's family. While such a finding invites speculation, it will be well to repeat Busemann's study on a larger number of cases before attaching great importance to his results.

In their examination of clinical data from the Institute for Juvenile Research, Thurstone and Jenkins (80) have reported that "it seems probable that there is a better prognosis for the behavior adjustment of a boy if he has a sister as a next older or next younger sibling."

Levy (54*a*) has also reported an unfavorable influence of sexually homogeneous sibships, finding that problem boys are more likely to have boy siblings immediately above and below. It is possible that such results are not incompatible with Busemann's, although we would hardly expect that a family constellation producing behavior problems would also favor acceleration in school.

Emotional Traits. Many writers have long considered the first-born,

and particularly the first-born who is also an only child, to be particularly handicapped in making a normal emotional adjustment.

One of the earliest compilations of data in this field was that of Kolrausche (53) in 1891. Comparing approximately seventy only sons with an equal number of boys having brothers, he found that of the former only 13 per cent "took part in school games regularly," and of the latter, 47 per cent.

Using a questionnaire method, Bohannon (11), in 1898, collected reports upon 381 only children. His conclusions enumerate the following grave charges against children of this group: (*a*) They are below the average in health and vitality. (*b*) Mental and physical defects of a grave character are much more common among them than among children generally. (*c*) They enter school later than other children, and are less regular in their attendance. (*d*) Their success in school work is below the average. (*e*) Peculiarities in these children seem to be more pronounced than in others. (*f*) They are more affectionate, more selfish, and more precocious.

In a compilation from clinical data, Friedjung (31) has reported that among only children in his practice 87 per cent show neuropathic traits, as compared with 31 per cent in families containing more than one sibling. Gastro-intestinal disorders, enuresis, insomnia, and emotional instability were more common among the only children.

It is, of course, obvious that studies such as those of Kolrausche, Bohannon, and Friedjung are subject to errors of sampling through the selection of families. The neuropathic tendencies of the only child, to the extent that they occur, may be partly a result of a deficiency in normal social contacts, over-solicitousness of the parents, parental disharmony, and other abnormal social elements in the family situation; it is likely, however, that they are also related to biological factors, such as maternal unfitness for child-bearing.

Busemann (17) studied a group of 400 children at a *Mittelschule;* these were chosen as representing a homogeneous social and economic group in order to make possible a valid comparison of families of varying size. Only children, and children in small families, were (by self-ratings) found to be more introverted and more dissatisfied with themselves, and (by teachers' ratings) more restless and hyperactive.

In agreement with this, Goodenough (37) has reported a greater degree of distractibility among only children, as judged by ratings in mental-test situations. In negativism, no significant differences were found in relation to birth position. Her sample included 990 children, from eighteen months to six years of age.

One of the most competent reports in this field is that of Goodenough and Leahy (38), who obtained teachers' ratings on 293 kindergarten children who had been under supervision for at least one term. The criticisms which are commonly leveled against ratings are not applicable in the case of a properly administered scale which is employed in the differentiation of groups. Table 11 presents some of the more striking

TABLE 11

Percentages in Each of Four Groups Who Are Placed in a Specific Classification

	Oldest $N = 64$	Middle $N = 59$	Youngest $N = 124$	Only $N = 46$
Aggressive	23	36	45	48
Seclusive	30	31	44	13
Introverted ("attention turned in")	48	30	36	21
Extremely submissive	21	15	8	4
Extremely timid and self-distrustful	28	24	20	15
Extremely suggestible	25	17	11	13
Extremely responsive to affection	9	14	6	17

group differences found by these investigations. The rating device employed was Blanton's, which provides for a marking of each trait on a linear scale, the center of the scale being the "ideal norm," while the left and right extremes represent a maladaptive deficiency or over-manifestation of the behavior in question. No reliable differences were found for "social adequacy," "attitude toward facts," "attitude toward property," "mood stability," "emotional response," or "emotional stability." But in the total of fourteen traits, the average percentages falling at the undesirable extremes were 22.5 for the oldest children, 20.6 for the middle, 16.5 for the youngest, and 19.7 for the only children. As compared with the youngest, the eldest children show a reliably greater incidence of undesirable ratings; they are judged to be low in aggressiveness, self-confidence, and leadership, and high in suggestibility, seclusiveness, and introvert tendencies. The only children are marked as aggressive and self-confident, extremely responsive to affection, gregarious, somewhat excitable, distractible, and unstable as to mood. The differences, while in some instances reliable, are of small magnitude. In accounting for the relatively poor record of the eldest child, Goodenough and Leahy mention several possible causative factors: the comparative inexperience of the parents in the case of the first-born, the imposition of tasks upon the eldest child, and the difficulty in changing from only child to non-only child. It is possible, however, that certain other factors may be chiefly responsible for the reported findings: (*a*) the weighting of certain traits in small families in connection with the biological and social factors which restrict family size; (*b*) the possible existence of a sampling factor. If, as was pointed out on page 567, a negative relationship exists between intelligence quotient and age at entering kindergarten, the effect of this will be to obtain a slightly selected group of younger children and an inferior selection of elder (first-born) children. This selection may also operate with reference to traits other than intelligence.

Two studies, by Ross (66*b*) and by Foster (30*a*), agree in suggesting

that disturbances due to jealousy are more common in the oldest child in the family. Among 1230 cases from the Institute of Child Guidance, Ross found 18 per cent of the oldest displaying jealousy, as compared with 12 per cent of middle and 8 per cent of youngest children. The first-born in families of two or three were more likely to be marked as "jealous" than the first-born in larger families.

Fenton (30) has quoted Hall, Blanton, Andrus, Coriat, Wexberg, and others as emphasizing the unfavorable position of the only child; in Hall's words, "being an only child is a disease in itself." Fenton was unable to find confirmation for this view; his study was based on teachers' ratings (by the Blanton scale) on approximately two hundred children in the kindergarten and lower grades. The only and non-only children gave closely similar distributions of teachers' ratings in such traits as aggressiveness, sociability, emotional stability, and initiative. In agreement with Goodenough and Leahy, the only children showed a slightly greater tendency to self-confidence; the difference, however, is apparently too small to be reliable.

For 100 only children at guidance clinics, Ward (84*a*) reported:

> "The problem behavior shown by the only children was very similar to that of all the clinic children . . . except in the manifestation of stealing, lying and truancy. The smaller frequency of these three problems among the only children could not be explained wholly on the basis of age differences, but was thought to be due to their living in a more sheltered environment where their wants were usually over-supplied and their contacts limited. As compared with a control group of three-child families the only children showed a higher percentage of restlessness and over-activity, crying, nail-biting and school difficulties."

In another group of clinic children, Bellerose (7*a*) found that the only child was not in general marked by emotional handicaps, although there was an apparent slightly greater tendency to food idiosyncracies and temper tantrums. For reasons which will be pointed out later, clinic cases are not well adapted for the investigation of group differences such as those involved in the present problem.

With older subjects (university students) Stratton (75) has reported that the first-born who are only children show no distinguishing emotional characteristics when compared with the first-born in a sibship. His data were derived from self-ratings of actual anger and fear responses in a large number of concretely specified situations. When the total group of first-born, however, was compared with the later-born, he found a statistically reliable difference in the intensity of anger responses. Stratton concludes:

> "Such emotional tendencies as are here indicated to exist in the first-born and not in those of later birth would seem to be connected with the primogeniture itself and with the relation which the child bears to the parents. This is not strange. For the first-born stands in a different relation to its parents, both physiologically and socially, from

that of children born in a later order. For the first-born the prenatal conditions are different, the conditions of birth are different, the conditions of parental training after birth are different. . . . The present evidence seems to indicate that the first-born is apt to be more irascible, to his advantage or disadvantage; and that this quality in him is not due to the presence or absence of brothers and sisters, but is independent of this special feature in family training."

The factor of family size, however, has not been fully regarded in this study. Stratton (74) has elsewhere reported a relationship between emotionality and the incidence of disease, a poorer health record being associated with higher emotional ratings. Since his later-born, taken as a group, involve a heavy weighting from large families, it is not unlikely that they derive, on the whole, from healthier stocks possessing a greater immunity to emotional episodes. The "irascible first-born," in other words, may perhaps be merely an accompaniment of an "irascible small family." In any event, it should be pointed out that the differences are slight, in terms of the variability of the total group, and that no differences are noted in the case of the ratings of fear responses.

The Woodworth-Mathews Personal Data Sheet has been used to compare only with non-only children with regard to self-judgments of social and emotional characteristics (Korn, 53*a;* Hooker, 45*a*). In these comparisons the only child has given a satisfactory account of himself; there is nothing to indicate that he is distinctive or "queer."

Fenton and Stuart have indicated a zero relationship between birth order and emotional normality in college groups. Among 512 students, Fenton (30) found no differences between oldest, youngest, and only children in total scores on the Woodworth Personal Data Sheet. Stuart (76) employed the Colgate Mental Hygiene Inventories in studying 465 students with reference to deviations from normal emotional expression; here, again, no differences were found in relation to birth order.

Similar results are reported by the Thurstones (81). The Thurstone Personality Schedule was given to 694 freshmen at the University of Chicago. On the basis of a well-executed analysis of the records, they concluded:

"Order of birth is not demonstrated to have any important relation to the development of a maladjusted or neurotic personality. This does not mean that being an only child, youngest child, oldest child, and so on, might not be an important contributory factor in the development of a neurotic personality. But our data do indicate that birth order is not so universally important a consideration in mental hygiene as is sometimes believed."

Perhaps on the side of those findings suggesting a greater emotionality of the first-born may be quoted the studies of Carman (19) and of McDonald (57), who employed a temple algometer in studying pain sensitivity. Among 1507 boys and girls, Carman found, in the case of boys, a decreasing pain sensitivity (or pain tolerance) with order of

birth. Size of family was not controlled. Among 53 college students, McDonald obtained results, of a low degree of reliability, suggesting that the first-born and the later-born are more sensitive than those of the middle birth ranks.

Another method of studying differences in relation to birth order is through the admission records of problem children in clinics. Such data are subject to some question as indications of the relative frequencies of behavior problems; it is possible that the external factors which influence admission to a clinic (such as the parents' desire for guidance) may vary in relation to birth position. A further difficulty arises from the factor of incompleteness of families; in incomplete families a larger proportion of the early-born will be within the age at which they are likely to be referred. This factor may be counteracted somewhat by the immigration of families into the clinic district; in such families, if the oldest is beyond the age limit, a weighting of the younger birth orders may occur. An increasing neighborhood tendency to patronize a clinic will also weight the younger birth orders.

Some of the earlier studies in this field may be neglected because the data were not presented in the form of a comparison of siblings, and no control groups were offered.

Thurstone and Jenkins (80) have eliminated the problem of incomplete families by utilizing clinic cases in which the subject was between the ages of seventeen and twenty-one. One hundred and one cases were represented, from the files of the Institute for Juvenile Research. Table 12 gives the observed percentages for each birth order, compared with the percentage to be expected on the basis of the distribution of their siblings (Pearson reconstruction). It may be noted that all cases were from separate families.

Rosenow (66) has dealt with a similar problem, making use of the data from child guidance clinics in Cleveland and Philadelphia. He regards his results as a demonstration of "the value of a check by means of statistical methods on generalizations achieved by means of clinical intuition." For, while an excess of the first-born occurred in the clinic, for all sizes of families up to six this excess became statistically unreliable when a cor-

TABLE 12

THE BIRTH-ORDER COMPOSITION OF A CLINIC SAMPLE

Birth order	Frequency of each birth order in Institute	Frequency of each birth order among their sibships
1	38.6	22.7
2	23.8	20.9
3	12.9	17.3
4	9.9	13.3
5	8.9	9.5
6	3.9	7.0
7 to 11	2.0	9.3

rection was made for the age factor (the first-born being, of course, older and more likely to have encountered problems requiring treatment). In a subsequent article Rosenow and Whyte (66*a*) found among clinic cases a slight preponderance of the first-born, which was not entirely accounted for when the incidence was corrected for age.

In a study of 322 child guidance cases in Minneapolis, Goodenough and Leahy (38) also found a slight excess of eldest children. With regard to the specific behavior problems reported, there was some indication that the middle children in the family, especially the girls, were more likely to exhibit sex misconduct, stealing, truancy, and other social offenses; the only children were inclined to be disobedient toward authority and to exhibit feeding problems and enuresis. Eldest children showed no specific characteristics but a generally high incidence in all of the classified types of problems. These writers point out, however, the probable importance of selective factors in determining clinical admissions and juvenile court records. It is instructive to compare with the clinic data results obtained by Wile and Noetzel (84*c*) for 500 children referred for health problems. When oldest, middle, youngest, and only children were classified as "explosive," "withdrawn," "enuretic," and "delinquent," no relationship was found to the family constellation. It appears to be easier, for some reason, to find such apparent relationships in a habit-clinic group than in samples selected on another basis.

One of the most significant compilations of data in this field is that of Levy (54*a*), who studied the ordinal position of 576 clinic cases in Chicago, and of 209 maladjusted children in the schools of a wealthy suburb; the results indicate that the influence of the family constellation may vary, as to direction and degree, in relation to cultural and economic status. Among the Chicago children a relatively heavy weighting occurred against the first-born, but this tendency was not apparent in the suburban families, which were of higher social status. Only children, on the other hand, showed a greater tendency to be maladjusted in the socially superior than in the large city sample. Such variations are not unexpected and suggest that investigators should formulate their problems not in general terms of "the effect of birth order," but with reference to a specific milieu.

In the study of psychoses, through the admission records of institutional cases, the chief difficulties which arise are those of (*a*) incompleteness of families, (*b*) aberrant sex ratios in institutions, and (*c*) the heterogeneous character of the classifications included under the term "legal insanity." In a study from the Galton Laboratory, Heron (43) reported a disproportionate percentage of first-born among approximately one thousand asylum inmates. The most recent investigation of this subject (Schuler, 69) covers 1224 cases in Minnesota institutions; in two-child families the marked individuals were more frequently first-born. Of those with paranoid dementia praecox nearly all were first-born.

In interpreting data based upon the admission records of institutional cases, the reader should bear in mind the following sources of error:

(*a*) the various conditions included under the term "legal insanity" possess different modal ages of onset, so that the birth-order weightings will (differentially in the several psychoses) be due in some part to an age weighting; (*b*) the normal sex ratio is subject to deviation in the various birth orders, in the groups marked by certain psychotic conditions, and in the groups marked by institutionalization. Hence, an apparent birth-order weighting may, on further analysis, prove to be a weighting of one age as compared with another or of one sex as compared with the other. Holmes has suggested that the incidence of syphilis deserves to be considered in this connection:

> "Mention may be made of one circumstance which might make a real difference between the first and subsequent members of a family, —and that is inherited syphilis. It is a well-known fact that the early born are most seriously injured by this disease. The not uncommon history of a syphilitic family is first the occurrence of one or more abortions, then the birth of weakly children and finally the production of children who are comparatively healthy. The inclusion of any considerable number of such family histories would tend to cause the first-born to occupy an unenviable position" (45, pp. 297-324).

As to other forms of abnormality, Hsiao (46) has listed, from various authors, a dismal catalogue of traits in which the first-born appear in some degree more heavily weighted; these include cancer, congenital cataract, congenital pyloric stenosis, myopia, and albinism. Hsiao regarded the evidence as unsatisfactory, and it may be noted that in a more recent investigation in this field (Macklin, 56) no support was found for earlier conclusions concerning developmental anomalies. In a study of 600 cases of hereditary defects, the first-born were shown to carry no more than the expected incidence of deviate conditions.

Delinquency. In the somewhat over-quoted inventory of the Jukes family, Dugdale (27) reported a greater tendency of the first-born to become criminals. Winter (87), in a group of 54 criminals, found a disproportionate number to be first-born, and accounted for this in terms of an increased predisposition to birth injury among children of primiparous mothers. Among delinquent boys, Burt (16) considered that he found an unduly large proportion of socially only children; this has not been confirmed in the study by Slawson (70) of delinquent boys in the New York House of Refuge; and Blatz and Bott (9), in an investigation of school children, reported that misdemeanors were fewest for the only children.

Tendencies toward incest have been asserted by von Hentig to occur with greater frequency among only children. As quoted by Thurstone and Jenkins (80): "Of his 92 incestuous persons 9.8% were only children, while the control group of 1660 soldiers showed but 4.1% only children. This is a difference of $5.7 \pm 2.13\%$, and so may be considered practically established." The matter is contingent, however, upon the validity of the control.

Two juvenile court studies are available, yielding conflicting results.

Among a group of 84 boys convicted of theft by a juvenile court, Baker and Decker (7) found a birth-order distribution which was closely in agreement with that in a control group; their method of establishing a control was superior to von Hentig's, the cases being matched as to age, school grade, neighborhood, and nationality. On the other hand, Breckenridge and Abbott (13), among a group of 584 delinquent boys in Chicago, reported that, in families of more than one, 138 were oldest and only 70 were youngest children. The possible effect of incomplete families was not controlled.

Conflicting opinions have also been derived from a study of adult criminals in England. Goring (39, p. 280) found an apparent excess of first-born and second-born, but attributed this to external selective factors, such as the reduced frequency (from infant mortality) of later-born in the population. From Goring's data, Pearson (63) has arrived at different conclusions, asserting that the actually observed first- and second-born frequency was approximately one-third greater than if the tendency to crime had been divided equally among all members.

It is to be hoped that a study will sometime be conducted in this field by the method of cumulative behavior records for entire sibships, accompanied by intelligence and other data for each birth order. In the present confused state of our knowledge, it is not merely difficult to explain the facts, but it is also difficult to know what the facts are. In this connection, it seems relatively profitless to study "crime" as an entity. Birth-order differences may emerge with respect to specific types of delinquency, which are concealed when all types are thrown into a common classification.

Birth Order in Psychoanalysis and Individual Psychology. Finally, we may consider certain psychoanalytic formulations concerning birth order. Since these are fundamentally hypotheses rather than conclusions upon specified data, a brief list of quotations will suffice to illustrate the range of clinical views in the field.

Brill (14) devotes a chapter to this topic, assigning the supposed peculiarities of the only child, and of the last-born after an interval, to the effects of parental solicitude and of lack of competition:

> "It is due to the undivided attention and abnormal love that the only child gets from his parents that he develops into a confirmed egotist. He is never neglected in favor of sisters and brothers, he is the sole ruler of the household, and his praises are constantly sung. It is, therefore, no wonder that the only child becomes vain and one-sided and develops an exaggerated opinion of himself. In later life he is extremely conceited, jealous and envious. He begrudges the happiness of friends and acquaintances and he is therefore shunned and disliked."

Hug-Hellmuth (47) emphasizes the unfortunate social circumstances of the middle child, particularly when the older and younger siblings are

of the same sex. It is the middle child that "feels most painfully the uncertainty of its position at home."

Adler (4), on the other hand, appears chiefly impressed by the disadvantages of the first-born:

> "The oldest child feels dethroned by the coming of his brother and wants to restore his place by fighting. Unless he can overcome in the struggle for supremacy in his universe he is apt to become depressed, peevish, more or less hopeless, and will show his hopelessness later in life if confronted by problems. He is very likely to be conservative, to understand power and to agree with it. If he is strong enough he becomes a fighting child.
>
> "As for the second child he is never alone, but is always confronted by the older child. This constant picture before him of an older and bigger child begets in him a sense of rivalry. If successful, he is an excellent type, but if defeated, for instance, if he is not able to compete successfully with the older child in work and in play, he loses hope, becomes depressed and has a bad time of it.
>
> "The third child has to fight for a place in the sun, but he has no successor. This gives him a great sense of power, and if he is capable he often overcomes the older children in the family by his sense of importance. If he is not capable, he perhaps hides behind the fact of being spoiled, and becomes lazy, escaping from tasks, wasting time and making excuses."

Oberndorf's (61) view of the rivalries between brothers is at variance with Adler's. The younger begins to regard his older brother as an adversary when the attachment to the mother reaches a certain stage of development. This antagonism, Oberndorf believes, is deeper and more intense than the jealousy or sense of martyrdom which the older sibling may feel with reference to his younger brother; by the time the younger child arrives, the first-born has already focused his strivings in another direction, namely, upon the father, who functions as the normal adversary in the Oedipus situation. This writer emphasizes the perpetual mutability of the family environment. . . . "the specificness, selectivity and individuality of the overdetermined attachments of siblings."

> "The familial environment of siblings is and never can be the same. Even if the parents' efforts to maintain an impartial attitude toward any two children were possible, the interaction of the siblings upon each other creates an ever-changing and variable situation. . . . Aside from the average difference in parental sibling attachment dependent upon the impulses operative in the Oedipus situation, deviation and disparity in feeling toward offspring depends very largely upon the degree to which each parent has found full psycho-sexual happiness in the marriage relationship. Parental libidinous disharmony often seeks compensation in an unequal and uneven attachment to a particular sibling, which in turn leads to an intensification of the customary sibling rivalries and affections for one another."

The reader who is impressed by the disagreement of psychoanalysts

concerning birth-order characteristics should not forget that our statistical studies are also filled with disagreement. The statements of the clinicians are not in any general sense descriptive or predictive, for they involve merely the listing of certain anomalies of development which may occur when normal compensations are lacking. But, while their offerings are "statistically inadequate," they lead fairly to the inference that on this problem mass statistics are themselves inadequate. A child's reactions to the circumstances of his birth order may vary in an extremely complex manner. The emotional or motivational "average score" for a given birth rank has in itself no explanatory significance and may serve merely to obscure the operation of diverse and sometimes opposing factors. Only a combination of clinical and statistical methods, checked by accumulative data upon growing children, will provide the insights and the techniques for practical control which this problem requires.

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CHAPTER 14

ENVIRONMENTAL FORCES*

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We have here to deal only with the psychological influence of the environment. This does not mean that the somatic effects of environment, for example, of nutrition or climate, do not have great psychological significance. On the contrary, the somatic as well as the psychological influence of the environment is constantly operating on the entire child.

INTRODUCTION

It has long been recognized that the psychological influence of environment on the behavior and development of the child is extremely important (cf. 42). Actually, *all* aspects of the child's behavior, hence instinctive and voluntary behavior, play, emotion, speech, expression, are co-determined by the existing environment. Some recent theories, notably those of Watson and Adler, assign to environment so predominant an influence upon development that hereditary factors are usually neglected (44, 2). Stern's theory of convergence emphasizes, on the contrary, that a predisposition and an environmental influence must operate in the same direction in order to effect a particular mode of behavior (41).

Average and Individual Milieu. The fact of environmental influence has been thoroughly established in various ways in recent years by the psychological study of various environments. For example, the intelligence of country children has been compared with that of city children (15, 22*a*), and the significance of size of family and position among siblings has been investigated (8). Research upon foster children (7*a*, 13*a*) and twins (13*b*) has also played an important part. In the case of identical twins one can be sure of equivalent hereditary capacities and dispositions. Similarities in conduct in the face of differences in environment may thus yield important information as to the kind and strength of the effects of environment, on the one hand, or of heredity, on the other.

Present-day investigation of the environment uses primarily *statistical* methods. The average of as many school records as were obtainable for only children is compared, for example, with that of oldest, middle, and youngest children in families of three. Particular environmental factors may be excluded to a certain degree, for example, in the investigation of the effect of size of family or of position in the series of siblings, by including only children of approximately equal economic status. These investigations have brought to light a wealth of interesting facts; for

*Translated from the German by Donald K. Adams.

example, that in certain social levels in Germany the number of children optimal for school achievement is three or four, but that in proletarian families, on the contrary, only children display, on the average, the best records (8).

Valuable and indispensable as these facts are, they can rarely offer more than hints toward the problem of the *forces* of the environment. For, in the investigation of the fundamental dynamic relations between the individual and the environment, it is essential to keep constantly in mind the actual total situation in its concrete individuality. The statistical method is usually compelled to define its groups on the basis not of purely psychological characteristics but of more or less extrinsic ones (such as number of siblings), so that particular cases having quite different or even opposed *psychological* structure may be included in the same group. Especially to be emphasized, however, is the following consideration: the calculation of an average, for example, of "the one-year-old child," is designed to eliminate the "accidents" of the environment; the determination of the average "situation" (for example, of the average effect of the situation of being an only child) is to exclude individual variations. But the very relation that is decisive for the investigation of *dynamics*—namely, that of the position of the actual individual child in the actual, concrete, total situation—is thereby "abstracted" (36). An inference from the average to the concrete particular case is hence impossible. The concepts of the average child and of the average situation are abstractions that have no utility whatever for the investigation of dynamics.[1]

The use of the average and the curve of distribution is unexceptionable where the object is to obtain a numerical value to characterize the position of a given individual in a group. For the discovery of dynamic laws, however, it does not suffice to segregate a single property or a phenotypically defined event, without regard to the structure of the total situation, and then to treat statistically as many as possible of those situations that display this characteristic.

The laws of falling bodies in physics cannot be discovered by taking the average of actual falling movements, say of leaves, stones, and other objects, but only by proceeding from so-called "pure" cases. Likewise, in psychology the forces of the environment and the laws of their operation on child behavior can be discovered only by proceeding from certain total situations that are "simple," but well defined in their concrete individuality. Only in this way, which usually implies experiment and systematic variation of conditions, can general propositions be made which will hold good even for the actual individual child and the concrete particular case.

It may, of course, be questioned whether it is possible to speak scientifically, i.e., with conceptual rigor, of dynamic properties, and

[1]Thus the environment researches become, in general, more fruitful the more attention is paid to a comprehension of the concrete total situation instead of to the number of cases.

especially of forces of the *psychological* environment.[2] Saying, for example, that bad treatment "oppresses" the child, or that praise "exalts" it, etc., may obviously have a merely figurative significance.

In biology the tropism theory of Loeb attempted to establish in a scientifically precise way dynamic relations between environmental stimulation and the behavior of certain animals. It has, however, been shown that the circumstance of the animals' "learning" implies essential modification (22), and moreover that their behavior depends upon their momentary "mood" (3).

The biologists at present have in part gone back to an indeterministic or at least a non-dynamic point of view according to which it is impossible to talk of a strictly lawful operation of environmental forces upon the individual. The influence of the environment is reduced essentially to the principle of trial and error. That is, the occurrence of the elementary actions is, so far as their relations to the environment are concerned, essentially accidental. The theory thus displays marked Darwinistic traits: it excludes the problem of a direct dynamic relation between environment and individual, and limits the effect of the environment to the evocation of *agreeable* or *disagreeable* experiences. This theory may be regarded as an attempt to avoid the uncomfortable concept of environmental forces in a psychological sense, and to derive an explanation of all behavior so far as possible from the organism itself.

In child psychology also the principle of trial and error is regarded as fundamental for the development of child behavior (7). On the other hand, it has recently been emphasized, first, that besides *"experience"* intrinsic maturation has fundamental significance for child development (41, 26, 7), and, secondly, that besides "blind" trial and error there is "insightful" behavior (26). In the case of insightful behavior the conduct of the individual is again brought into *immediate* relation to the special structure of the situation.

Individual, Environment, and Law. Before we consider in detail the question of the psychological forces of the environment, we must discuss briefly the relation of the concepts environment, individual, and law. Environment is understood psychologically sometimes to mean the *momentary situation* of the child, at other times to mean the *milieu,* in the sense of the chief characteristics of the permanent situation. The following considerations apply to both concepts.

The actual behavior of the child depends in every case both upon his individual characteristics and upon the momentary structure of the existing situation. It is not possible, however, as is increasingly obvious, simply to separate out one part which shall be attributed to the environment and another to be ascribed to the individual. But even when the primitive question, "Which is (in this case) more important, heredity or environ-

[2]The speculative philosophical grounds which might be urged against such an attempt are not considered here. In America they are usually of a physical nature, in Germany partly physical and partly *geisteswissenschaftlich.*

ment?" is given up, and the thesis is advanced that heredity and environment must work in the same direction in order to effect a certain mode of behavior, it is still assumed that hereditary dispositions may be defined as tendencies toward certain real modes of behavior *without* reference to a particular environment. Actually, reference to a specific environment, indeed, to an aggregate of specific environments, is indispensable to the concept of predisposition: a predisposition or individual characteristic of the person P_a (cf. *infra*) cannot be defined by one specific mode of behavior, but only by an *aggregate* of modes of behavior of such kind that different environmental situations (E_1, E_2, . . .) are correlated with the modes of behavior (B_α, B_β . . .) they elicit. The individual characteristics of a person as regards both predisposition and momentary state are thus to be defined not *phenotypically* but *genotypically* in dealing with dynamic problems.

The variations in behavior (B_α, B_β, . . .) with the same individual characteristics may be extremely large. A child that is negativistic in one situation may be shy in another and at ease in a third. Thus Kramer found in 100 per cent of his cases that bestial children lost their bestial behavior so completely when brought into an appropriate environment that they might better be characterized as dainty.

Sensitivity to environment varies considerably in different individuals. In general it is greater in psychopathic than in normal children (18).

In order for one individual characteristic[3] (P_a) to be differentiated from another (P_b) it must be associated with *different* modes of behavior

$$P_a = \begin{cases} E_1 \rightarrow B\alpha \\ E_2 \rightarrow B\beta \\ E_3 \rightarrow B\gamma \\ \cdot \\ \cdot \\ \cdot \\ E_n \rightarrow B\nu \end{cases} \qquad P_b = \begin{cases} E_1 \rightarrow B\zeta \\ E_2 \rightarrow Bo \\ E_3 \rightarrow B\alpha \\ \cdot \\ \cdot \\ \cdot \\ E_n \rightarrow B\mu \end{cases}$$

(B) in the *same* situations (E_1, E_2, E_n). Thus, on the whole, different individuals may often display the same (or very similar) modes of behavior (B). Watson and Adler emphasize this similarity, and probably the ultimately *possible* modes of behavior of very many people might indeed show a considerable, if not a complete, measure of agreement. But this similarity of possible behavior does not imply similarity of the individuals, because it requires different situations to bring out (approximately) similar behavior.[4] Neither similarity nor difference in behavior (B) permits of direct unequivocal inference of similarity or difference of individual characteristics or of situation factors. Inference of an individual

[3]These considerations apply equally to a single characteristic or personality trait and to the whole personality.

[4]These situations must, in general, be more different the more different the individuals.

characteristic (P) is possible only when the environmental situations (E) agree, inference of the situation only when the individuals agree.[5]

In such cases, to be sure, the inference is unequivocal. Indeed, psychological *laws* really say the same thing in another way: from a certain total constellation—comprising a situation and an individual—there results a certain behavior, i.e., $(E_1, P_a) \rightarrow B_a$, or in general $B = f(PE)$.

In reality, *the dynamics of environmental influences* can be investigated *only simultaneously with the determination of individual differences* and investigation of *general psychological laws*. The discovery of psychological laws, on the other hand, yields important insights into the significance of environmental factors and individual characteristics. It will be plain from these considerations what vital importance the systematic—especially the experimental—investigation of environmental changes with the same individual[6] has for the study of the environmental forces.

Environmental Structure and Needs. An analysis of environmental factors must start from a consideration of the total situation. Such an analysis hence presupposes an adequate comprehension and *presentation* in dynamic terms of the total psychological situation as its most important task.

Loeb's theory, by and large, identifies the biological environment with the physical environment: the dynamic factors of the environment consist of light of specific wave-length and intensity, gravity, and others of similar nature (11). Others, notably von Uexküll, have shown, on the contrary, that the biological environment is to be characterized quite differently, namely, as a complex of foods, enemies, means of protection, etc. The same physical situation must thus be described for different species of animals as a specifically different phenomenal and functional world (*"Merk- und Wirkwelt"*).

In child psychology, also, the same physical environment must be quite differently characterized according to the age, the individual character, and the momentary condition of the child. The "life-space" of the infant is extremely small and undifferentiated. This is just as true of its perceptual as of its effective space (29, 5, 12*a*). With the gradual extension and differentiation of the child's life-space, a larger environment and essentially different facts acquire psychological existence, and this is true also with respect to dynamic factors. The child learns in increasing degree to "control" the environment. At the same time—and no less important—it becomes psychologically *dependent* upon a growing circle of environmental events.

When, for example, one breaks a doll a few feet away from a baby, the latter is unaffected, while the same procedure with a three-year-old usually calls forth energetic intervention.

[5]Even if the Watson-Adler thesis that the overwhelming majority of mankind is capable of most tasks were right, it would imply neither similarity of endowment nor the decisive importance of environmental factors.

[6]Only in the same individual or in identical twins can one be sure of dealing with the same individual characteristics.

The later extension of the child's space-time beyond the room and the family circle also means not only an intellectual survey of wider relationships but, above all, an extension of the environmental objects and events upon which the child is psychologically immediately dependent.

The mere *knowledge* of some thing (for example, of the geography of a foreign country, of the economic and political situation, or even of immediate family affairs) does not necessarily change the child's life-space more than superficially. On the other hand, psychologically critical facts of the environment, such as the friendliness or unfriendliness of a certain adult, may have fundamental significance for the child's life-space *without* the child's having a clear intellectual appreciation of the fact.

For the investigation of dynamic problems we are forced to start from the psychologically real environment of the child.

In the "objective" sense, the existence of a *social* bond is a necessary condition of the viability of an infant not yet able itself to satisfy its biologically important needs. This is usually a social bond with the mother in which, functionally, the needs of the baby have primacy.

But social facts, as essential constituents of the *psychobiological* environment, very early acquire dominant significance. This does not mean, of course, when the child of three months reacts specifically to the human voice and to a friendly smile (cf. 6, 17), that the relation to certain individuals has already become a stable constituent of the child's psychological environment. The age at which this will occur depends essentially upon the individual endowment and the experiences of the child.

The fact that certain activities (e.g., playing with certain toys) are "allowed" and others "forbidden" (45) (e.g., throwing things, or touching certain objects belonging to the "grown-ups") begins very early—certainly before age two—to play an important dynamic part in the structure of the child's environment. With the growth of the child social facts usually acquire more and more significance for the structure of the psychological environment.

Social facts such as friendship with another child, dependence upon an adult, etc., must also be regarded, from the dynamic point of view, as no less *real* than physical facts. Of course, in the description of the child's psychological environment one may not take as a basis the immediately "objective" social forces and relations as the sociologist or jurist, for example, would list them. One must, rather, describe the social facts as they affect the particular individual concerned (37*a*). For the "objective" social factors have no more an unambiguous relation to the psychological individual than objective physical factors have. Exactly the same physical object may have quite different sorts of psychological existence for different children and for the same child in different situations. A wooden cube may be one time a missile, again a building block, and a third time a locomotive. What a thing is at any time depends upon the total situation and the momentary condition of the child involved. Similar considerations hold also for the social factors.

In this dependence there becomes clear a matter of fundamental psychological importance, namely, *the direct relationship between the momentary state of the individual and the structure of his psychological environment* (cf. 30, 37*a*). That the psychological environment, even when objectively the same, depends not only upon the individual character and developmental stage of the child concerned but also upon its *momentary* condition, becomes clearest when we consider the relationship between environment and *needs*.

Besides the quasi-physical and quasi-social environment, a mental task or a phantasy must sometimes be characterized from the dynamic point of view as environment. Activities, e.g., a game, may have the character of a region into or out of which the child may go. In the same sense a mathematical problem may have this character. The description of the child's environment would be incomplete without including the whole world of phantasy which is so important for the child's behavior and so closely connected with its ideals and with its ideal goals.

In the environment there are, as we have seen, many objects and events of quasi-physical and quasi-social nature, such as rooms, halls, tables, chairs, a bed, a cap, knife and fork, things that fall down, turn over, can start and go of themselves; there are dogs, friends, "grown-ups," neighbors, someone who rarely gets cross and someone who is always strict and disagreeable. There are places where one is safe from rain, others where one is safe from adults, and still others where one may not go under any circumstances. All these things and events are defined for the child partly by their "appearance" but above all by their *"functional possibilities"* (the *"Wirkwelt"* in von Uexküll's sense). The stairs are something that one can (or cannot yet) go up and down, or something that one climbed yesterday for the first time. Thus *history*, as the child has experienced it, is also a psychologically essential constituent of the things of the environment.

With all these, however, there remain certain critical properties of the psychobiological environment still undescribed. Objects are not neutral to the child, but have an immediate psychological effect on its behavior: many things *attract* the child to eating, others to climbing, to grasping, to manipulation, to sucking, to raging at them, etc. These imperative environmental facts—we shall call them valences[7] (*Aufforderungscharak-*

[7]These valences are not to be confused with what is generally understood by "stimulus," as the term is used in speaking of a stimulus-reaction process. The effect of the valences corresponds dynamically much more nearly to a command, a summons, or a request. A fairly precise translation of *"Aufforderungscharakter"* is the term "demand value" which Tolman (43*a*) uses for the same concept. In order to avoid unnecessary misunderstandings, Professors Tolman and Lewin have agreed to use the same term, and, at Tolman's suggestion, have chosen *"valence."*

[There is no good English equivalent for the author's use of *"Aufforderungscharakter." "Positive"* and *"negative Aufforderungscharaktere"* might be accurately rendered by "attractive" and "repulsive characters," were it not desirable, for various reasons, to have a neutral term. Perhaps the most nearly accurate translation for the expression would be "compulsive character, but that is cum-

tere)—determine the *direction* of the behavior. Particularly from the standpoint of dynamics, the valences, their kind (sign), strength, and distribution, must be regarded as among the most important properties of the environment.

The valence of an object usually derives from the fact that the object is a means to the satisfaction of a need, or has indirectly something to do with the satisfaction of a need. The kind (sign) and strength of the valence of an object or event thus depends directly upon the momentary condition of the *needs* of the individual concerned: the valence of environmental objects and the needs of the individual are correlative (30). (Concerning induced valence, see page 611 below.) Even with objective identity of environment, the strength and the appearance of the valences are quite other for a hungry child than for a satisfied one, for a healthy child than for a sickly one.

The correlation between valence and environment leads to a fundamental change in the latter with the changing needs of increasing age. The objects bearing valences are different for the baby, the toddler, the kindergartner, and the pubescent (37*a*).

The valences change also with the *momentary state* of the needs. When the need for nourishment, for playing with a doll, or for reading history is in a "hungry" or unsatisfied condition, a bit of food, a doll, or the history book attracts the child, i.e., has a *positive* valence; whereas, when this need is in a stage or state of satisfaction, the object is indifferent to the child; and, in the stage of "over satiation" of the need, it becomes disagreeable to the child, i.e., it acquires a *negative* valence (23, 24, 33).

Since the psychological environment, especially for the child, is not identical with the physical or social environment, one cannot, in investigating environmental *forces,* proceed from the physical forces as Loeb, for example, does in biology. If we start primarily from the *psychobiological* environment and pay due attention to its dependence upon the actual momentary condition of the individual involved, it is quite possible to discover universally valid principles of the dynamic effects of the environment. To be sure, it will always be necessary to keep in mind the *total* structure of the existing situation.[8]

Psychological *environmental forces* (*Umweltkräfte*) may be defined empirically and functionally, excluding all metaphysical problems, by their effect upon the behavior of the child.[9] They are equally applicable to

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brous and a shade too strong. In consultation with the author it has been decided to do a very little violence to an old use of the word "valence." (Cf. the New English Dictionary.) It should be noted, in contrast to chemical valence which is only positive, that psychological valence or *a* psychological valence may be either positive (attracting) or negative (repelling), and that an object or activity loses or acquires valence (of either kind) in accordance with the needs of the organism.—Translator's note.]

[8]By situation is meant the psychological situation, with particular reference to its dynamic properties.

[9]The fundamental concepts of psychological dynamics are thus for the present to be defined purely from the point of view of psychology and biology. Whether they agree in their formal logical structure with the fundamental dynamic concepts of physics need not here be discussed.

the momentary situation and to the permanent environment of the child.

In summary: to understand or predict the psychological behavior (B) one has to determine for every kind of psychological event (actions, emotions, expressions, etc.) the momentary whole situation, that is, the momentary structure and state of the person (P) and of the psychological environment (E). $B = f\ (PE)$. Every fact which exists psychobiologically must have a position in this field and only facts which have such position have dynamic effects (are causes of events). The environment is, for all of its properties (directions, distances, etc.), to be defined not physically but *psychobiologically*, that is, according to its quasi-physical, and quasi-social, and quasi-mental structure.

It is possible to represent the dynamic structure of the person and of the environment by means of mathematical concepts. The coordination between the mathematical representation and its psychodynamic meaning has to be strict and without exception.

We shall first describe the psychological field forces and their mode of operation, without consideration of the question whether the object in any particular case has acquired its valence through some previous "experience" or in some other way.

The Region of Freedom of Movement—Forces and Fields of Force

The first presupposition for the understanding of the child is the determination of the psychological "place" at which the child concerned is, and of his region of freedom of movement, i.e., of the regions that are accessible to him and of those regions that psychologically exist for the child but which are inaccessible to him by reason of the social situation (prohibition by the adult, limitation by other children, etc.) or because of the limitations of his own social, physical, and intellectual abilities. Whether his region of freedom of movement is large or small is of decisive significance for the whole behavior of the child (46, 37).

One can characterize these possible and not possible psychodynamic locomotions (quasi-bodily, quasi-social, quasi-mental locomotions) at every point of the environment with the help of the concept of *topology*, which is a non-quantitative discipline about the possible kinds of connections between "spaces" and their parts.

The basis for the coordination between mathematical and *psychodynamic* concepts so far as environmental questions are concerned is the coordination of topological *path* and psychodynamic *locomotion*. The topological description determines which points the different paths lead to and which regions these paths cross. One can characterize the region which a child cannot reach by means of *barriers* between these regions and their neighboring regions. The barrier corresponds as a dynamic concept to the mathematical concept of boundary. One must distinguish between different strengths of barriers (12*a*).

Fundamental Properties of Field Forces. To determine not only which

locomotions (paths) are possible but which of the possible locomotions will occur at a given moment one has to use the concept of *force*.

A force is defined through three properties: (1) direction, (2) strength, (3) point of application. The first and second properties are to be represented through the mathematical concept *vector*. The point of application is indicated in the figures (as is the custom in physics) by the point of the arrow.

Dynamically the force is correlated with psychobiological locomotions in a one-to-one correspondence. "The real locomotion must occur in every case according to the direction and the strength of the resultant of the momentary forces" and "in any case of locomotion there exists a resultant of forces in its direction."

The direction which the valence imparts to the child's behavior varies extremely, according to the content of the wants and needs. Nevertheless, one may distinguish two large groups of valences according to the sort of initial behavior they elicit: the *positive* valences (+), those effecting approach; and the *negative* (—), or those producing withdrawal or retreat.

The *actions* in the direction of the valence may have the form of uncontrolled impulsive behavior or of directed voluntary activity; they may be "appropriate" or "inappropriate."

Those processes which make an especially "goal striving" impression are usually characterized dynamically by a reference to a *positive* valence (37).

One has to distinguish between *driving* forces (which correspond to

FIGURE 1

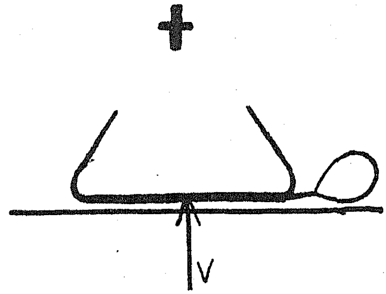

FIGURE 2

positive or to negative valences) and *restraining* forces which correspond to barriers.

Direction of the field force. That the valence is not associated merely with a subjective experience of direction, but that a directed force, determinative of the behavior, must be ascribed to it, may be seen in the fact that a change in the position of the attractive object brings about (*ceteris paribus*) a change in the direction of the child's movements.

An especially simple example of an action in the direction of a positive valence is illustrated in Figures 1 and 2. A six-months-old infant stretches arms, legs, and head toward a rattle or a spoonful of porridge in accordance with the direction of the vector (V).

The direction of the field forces plays an important part in such intelligent behavior as has to do with detour (*Umweg*) problems. The child perhaps wants to get a piece of chocolate on the other side of a bench. (See Figure 3, C=child, Ch=chocolate, B=bench.) The difficulty of such a problem consists primarily, not in the *length* of the detour (D), but in the fact that the initial direction of the appropriate route does not agree with that of the vector from the valence. The detour is more difficult, *ceteris paribus,* the more the barrier makes it necessary for the child in making the detour to start off in a direction opposed to the direction of the valence (Figure 4).

The situation is similar when the child wants to take a ring off a stick, while the stick stands in such a way that the ring cannot be pulled directly

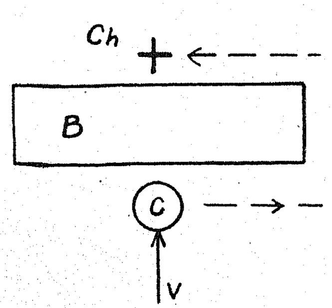

FIGURE 3

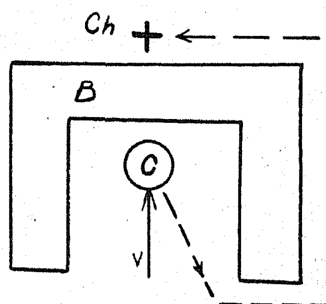

FIGURE 4

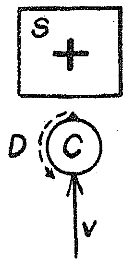

FIGURE 5

toward the child, but must first be moved upward, or away from himself. Similar factors are operative when a child at a certain age may have difficulties in sitting down on a chair or a stone. The child approaches with its face toward the stone (S). In order to sit down it must turn around, i.e., execute a movement opposed to the direction of the field force (Figure 5) (34).

When the child finds the solution of such a detour problem, it happens by reason of a restructuring of the field (27). There occurs a perception of the total situation of such a kind that the *path to the goal* becomes a unitary whole. The initial part of the route, which "objectively" is still a moment away from the goal (cf., e.g., Figure 4), thereby loses psychologically that character and becomes the *first phase* of a general movement *toward* the goal.[10]

How critically important the question of *direction* is in this case is indicated by the fact that one cannot force a solution of the detour by increasing the *strength* of the valence. If the attraction is much too weak, it is, to be sure, unfavorable, because the child does not concern himself sufficiently with the affair.[11] But if we continue to strengthen the valence, the solution of the task ceases to be facilitated and instead becomes more difficult. The strength of the attraction then makes it doubly difficult for the child to start in a direction opposed to the field force. Instead, the child will execute, with all its energy, affective meaningless actions in the direction of the valence (cf. *infra*).[12] Above all, that relative detachment and inward "retirement" from the valence which is so favorable to perception of the whole situation and hence to the transformation (*Umstrukturierung*) of the total field, which occurs in the act of insight, is made much more difficult (cf. *infra*). For the same reason, the prospect of an especially intense reward or punishment may impede the solution of intellectual tasks.

[10]Frequently this transformation is not immediately complete, and the first part of the route retains a sort of double character.

[11]Bogen found, even among school children who were working on such tasks voluntarily, that solutions were found more frequently if the valence of the goal was strengthened by the addition of a piece of chocolate (cf. 4).

[12]The impulsive struggles of Thorndike's cats may have been due in part to such a situation (cf. 43).

To older children of normal intelligence the preceding examples of detour problems offer no difficulty, because they already have a sufficient survey of such situations or corresponding experiences. For them, it no longer requires a special act of intelligence in order that, instead of the spatial directions, the *functional* directions become decisive for the movement.

We may at this point remark a circumstance of general importance: direction in the psychological field is not necessarily to be identified with physical direction, but must be defined primarily in psychological terms. The difference between psychobiological and physical direction appears more prominently in older children. When the child fetches a tool or applies to the experimenter for help, that does not mean, even when it involves physical movement in a direction opposite to the goal, a turning-away from the goal, but an approach to it. Such indirect approaches are more rare among babies. This is due to the slighter functional differentiation of their environment and to the fact that *social* structure has not yet the overwhelming significance for them that it has for older children. Fajans (13) found, for example, that in a certain situation in which three- and four-year-old children usually applied to the experimenter for help (indirect approach) the corresponding turning of the baby to its mother was more a withdrawal from failure than a seeking for help.

In the cases mentioned, the direction of the field forces is determined by objects which, by reason of visual or auditory distance perceptions, have a definite place in the environment. In the case of newborn children one can speak of such precisely directed field forces only in so far as the psychological environment has sufficient structure and solidity.

Directed action in response to certain forms of *tactile* stimulation may be observed very early. Touching the child's cheek with the nipple may elicit a turning of the head in the corresponding direction.

Also among older children the (psychological) *separation of the self from the valence* remains in many respects a necessary condition for the action upon the valence. Fairly often the action does not proceed immediately to the use of the object, but the field force disappears (or is at least very much weakened) as soon as the object comes into the "possession" of the individual involved. An example from our films: a nine-months-old child before which two rattles are laid does not begin to play after getting one of them, but is interested only in the rattle that he does *not* have. The close relationship between directed field forces and the separation of the self from the goal object can also be demonstrated in various ways with older children.

Strength of the field forces. For the strength of the valences, internal factors, especially the actual momentary state of the child's needs, are of crucial significance (23). In addition, the strength of the field force going out from a valence depends also upon the *position* of the valence relative to the individual and upon the presence or absence of other valences.

Fajans (30) has shown that, *ceteris paribus,* at least in certain cases, the strength of a valence increases with its apparent *proximity.* This is expressed by both the duration and the intensity of the efforts toward the goal. (In these experiments actual attainment of the goal was impossible.)

In a group of babies, approximately ten months old, for example, the average total duration of approaches in the first three minutes at distances of 9, 40, and 100 centimeters was respectively 75, 39, and 27 seconds. In a group of three-year-olds the average total duration of approaches in the "near" experiment was 58 seconds, in the "far" experiment 28 seconds. The degree of activity, as well as the duration of approaches, increases with the proximity of the valence. The reason for this is different for younger and older children.

Again one may not, to be sure, simply assume that psychological distance corresponds to physical distance. In the first place, a difference in apparent distance is significant only within a rather narrowly limited range, in accordance with the smallness of the child's life-space; and this range, as the work of Fajans shows, is considerably smaller for the one-year-old than for the three-year-old child. Just as visual extent in perceptual space (for example, with reference to the law of apparent size) increases with age (29), the life-space of the child increases and differentiates in dynamic respects as well. Difference in distance cannot be purely physically defined also because the range in which the child "almost" gets the desired object has qualitatively a special character. This *"almost" situation* has an especially marked significance, e.g., with reference to experiences of success and failure, and cannot be reckoned simply as a smaller distance (cf. *infra*).

An obvious discrepancy between spatial and psychological distance was observed in a group of four-year-old children who experienced the situation less as an "objective task" than as a *social* relationship with the experimenter. They were simply faced by an adult who would not give them a doll. For these children the kind and duration of approach remained independent of the distance of the valence. Indeed, for the social route to the valence (by way of the experimenter) the psychological distance is the same in any case.

With older children the intellectual appreciation of the functional and particularly the sociological relations (perhaps of their dependence upon the might of other children and of adults) is so far developed that physical distance usually plays a much smaller part in such situations.[13]

Weiss found in her Fraenkel experiments (cf. *supra*) with rather uninhibited five-year-old children that the distance of the toys on the table was no longer important to the choice made; the child fetches what it wants. To be sure, when inhibitions are present, the distance again plays a considerable rôle, even with older children.

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[13]Of course, where very strong valences are concerned, or very fundamental needs, primitive physical distance usually plays a considerable rôle, even with adults.

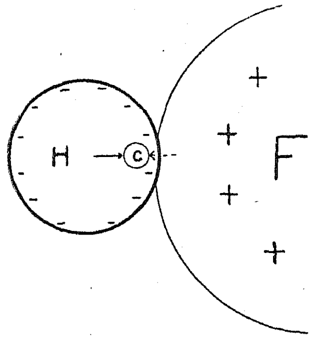

FIGURE 6

With increasing age *temporally* distant events also acquire increasing significance. To the psychological situation belong not only those facts that are actually perceptible and "objectively" present, but also a range of past and future events. A censure or a commendation may long remain a *present* psychological fact for the child, and an expected event may have psychological reality in advance of its occurrence.

As an example of the increase in the strength of the valence with *temporal proximity,* it may be pointed out that, among the inmates of homes for delinquent children, reform schools, and similar institutions, it is not infrequently observed that they become especially difficult just before their discharge. We noted this paradoxical behavior, so sharply opposed to their own interests,[14] especially in previously well-behaved individuals. The essential reason was found to be the following: Even for the youth who is at first well-behaved in the home the wish for freedom is an important motive of his behavior. But at first this freedom is a distant half-imaginary goal and, most important, good conduct in the home is the way that shall ultimately lead him there. Now that his discharge is approaching, the longed-for, but until now uncertain, world of freedom is just ahead (Figure 6). The boundary of the home thereby acquires in much greater degree the character of a marked barrier (*B*) which separates the youth from his almost-attained goal. Hence the home acquires a pronounced negative valence. Emotional and rebellious actions are further facilitated by the very high *state of tension* (*vide infra*) and by the fact that the youth already feels half free.[15] In a topologically similar experimental situation with infants an increase of affectivity occurred in 85 per cent of the cases when the field forces in the direction of the goal behind the barrier were strengthened and the general state of tension thereby raised (13). In many cases the impatience of children can be explained by a similar structure of the environment.

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[14]It not infrequently happens that the prospective discharge is thereupon revoked.

[15]It has happened that a prisoner sentenced to three years tried to escape within a week of his discharge.

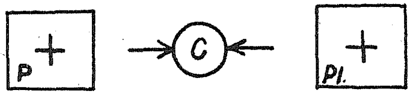

FIGURE 7

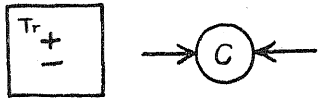

FIGURE 8

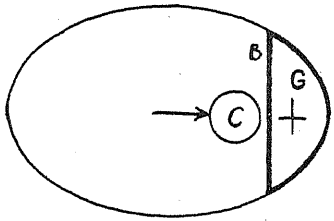

FIGURE 9

The experiments of Fajans show that the restraining forces corresponding to the barrier increase when the strength of the valence behind the barrier is increased. (See p. 609.)

Constellations of Forces. Conflict. The ways in which different valences may interact in a situation are naturally very numerous. In the following I select for discussion the case of conflict because of its special significance.

Conflict is defined psychologically as the opposition of approximately equally strong field forces. There are three basic cases of conflicts as far as driving forces are concerned.

1. The child stands between two positive valences (Figure 7). He has to choose perhaps between going along on a picnic (*P*) and playing (*Pl*) with his comrades. In this type of conflict situation decision is usually relatively easy. As a result of the fact that after the choice the goal chosen often seems inferior (for reasons to be described later), oscillation does sometimes occur.

2. The child faces something that has simultaneously both a positive *and* a negative valence (Figure 8). He wants, for example, to climb a tree (*Tr*), but is afraid.

This constellation of forces plays an important part in cases in which a reward is offered for an activity (e.g., a school task) which the child does not want to execute.[16]

Conflict situations of this type usually develop rather quickly also in the detour experiments mentioned above, in the experiments of Fajans, or in similar situations in which the attainment of a goal is impeded by some barrier. At first the child sees a difficult way through a barrier (*B*) between himself and his goal (G), which hinders the completion of actions in the direction of the field forces (Figure 9). But after the child has run against the barrier several times, and perhaps hurt himself, or had the wounding experience of failure, the barrier itself acquires a negative

[16]For these and the following remarks cf. (37).

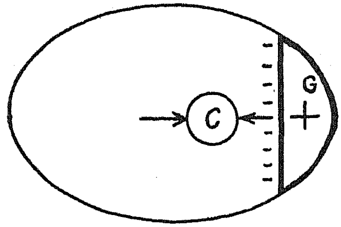

FIGURE 10

General Topology of the Situation with a Barrier between the Child and His Goal

valence (Figure 10). Besides the positive, there comes into existence a negative vector, and we have the Type 2 conflict situation. The negative vector usually increases gradually in strength and finally becomes stronger than the positive. Accordingly, the child *goes out of the field.*

This withdrawal (*Aus-dem-Felde-Gehen*) may be either physical, as when the child retreats, turns away, or possibly leaves the room or place, or it may be an *inward* going out of the field, as when the child begins to play or to occupy itself with something else. It not infrequently occurs, for example in embarrassment, that the child makes certain bodily movements toward the goal but at the same time is mentally occupied with something else. In such cases the bodily act has the character of a more or less set "gesture" (32, 13).

In such situations the withdrawal is at first almost always merely temporary. The child turns away, only to return after a while for another try at the barrier (13). A final and permanent withdrawal usually occurs only after several temporary withdrawals, the *duration* of which increases until finally the child does not return.

Unusual persistence in such a situation is not necessarily an indication of *activity*. On the contrary, active children usually "go out of the field" earlier than passive children. It is not the duration but the *kind* of approach that is significant for activity (13). Related to this is the fact that under certain circumstances the single actions in such a conflict situation are longer with the infant than with the young child (18), although in general the duration of action unities increases with the age of the child (5).

3. The third type of conflict situation occurs when the child stands *between* two *negative* valences, for example, when it is sought by threat of punishment (P) to move a child to do a task (T) it does not want to do (Figure 11).

There is an essential difference between this and the conflict situation described under 1. This becomes clear when one proceeds to represent the total distribution of forces in the field of force.

Field of Force. The field of force indicates which forces would exist

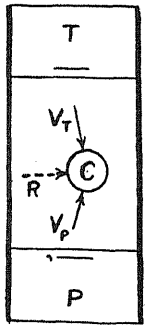

FIGURE 11

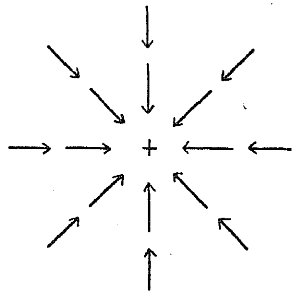

FIGURE 12

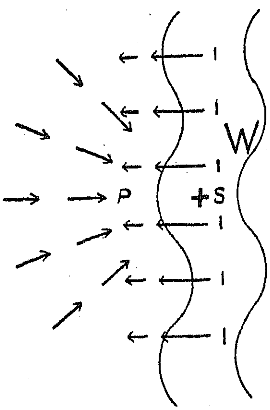

FIGURE 13

at each point in the field if the individual involved were at that point. To a positive valence there corresponds a central field (Figure 12).

As a simple example of the structure of the field of force in a conflict situation of Type 2, a case from one of my films may be adduced: A three-year-old boy wants to fetch a rubber swan out of the water to the beach, but is afraid of the water. To the swan (S) as positive valence there corresponds a central field. This field is overlaid by a second field which corresponds to the negative valence of the waves (Figure 13). It is important that here, as frequently in such cases, the *strength* of the field forces which correspond to the negative valence diminishes much more rapidly with increasing spatial *distance* than do the field forces corresponding to the positive valence. From the direction and strength of the field forces at the various points of the field it can be deduced that the child must move to the point P where *equilibrium* occurs. (At all other points there exists a resultant which finally leads to P.) Corresponding to the momentary oscillations of the situation, above all to the more or less threaten-

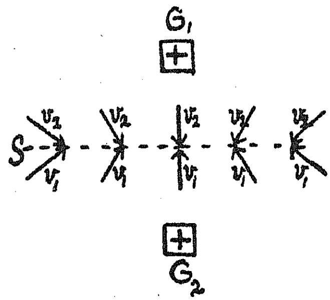

FIGURE 14
(Situation A)

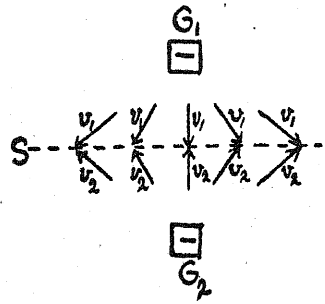

FIGURE 15
(Situation B)
(From K. Lewin's "Vectors, Cognitive Processes, and Mr. Tolman's Criticism." *J. Gen. Psychol.*, 1933, 8, 341.)

ing aspect of the waves, this point of equilibrium approaches and retreats from the water. Indeed, this oscillation is reflected in the child's approaches to and retreats from the water.

If we return now to Type 3 of the conflict situation and compare it with Type 1, the chief difference is shown in Figures 14 and 15: in both cases two central fields overlap. But while in Type 1 a *stable* equilibrium exists at the point P (Figure 14) so far as sidewise movements (on line S) are concerned, in Type 3 this equilibrium is *labile* (Figure 15). That is, there exists in the case of threat of punishment a situation which evokes a tendency to break out toward the side, in accordance with the strong sidewise resultant (R) of the two vectors (V_p and V_t in Figure 11 *supra*). Consequently in such a case, the child always goes out of the field unless other circumstances prevent it. Hence, if the threat of punishment is to be effective, the child must be so inclosed by a barrier (B) that escape is possible only by way of the punishment or by doing the disagreeable task.[17] That is, in addition to requiring the execution of the task, it is

[17]The barrier may derive its firmness psychologically from the power of the adult, from the child's sense of honor, or from some other such factor (cf. 37).

necessary to limit the child's freedom of movement, thus creating (by physical or social means) a more or less constrained situation.

With the young child, the opposition of two approximately equal field forces in the conflict situation leads typically (so far as it is not an unstable equilibrium) to a relatively rapid *alternation* of actions in the direction, in turn, of each of the two field forces. It is a characteristic indication of greater *self-control* when, instead of this oscillation of action the child displays a relatively calm type of behavior while the conflict remains unresolved.[18]

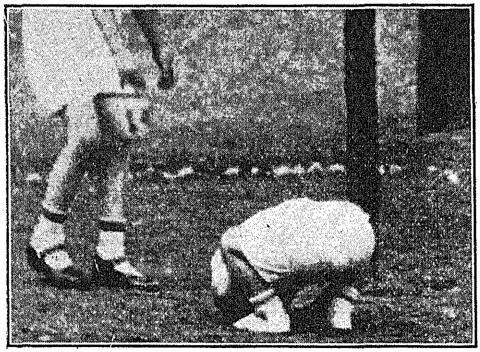

FIGURE 16

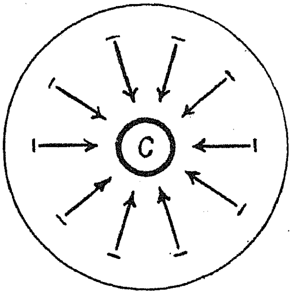

FIGURE 17

Ability to endure such unresolved conflict situations is an important aim of the education of the will. Of course, the occurrence of such conflict situations presupposes that the two opposed field forces are of approximately *equal* strength. If threats of punishment, pressure from the adult, or other restrictions leave the child little enough freedom, no real conflict situation can develop.

If a situation becomes "hopeless," that is, if it becomes as a whole inescapably disagreeable, the child, despairing, *contracts,* physically and psychically, under the vectors coming from all sides, and usually attempts to build a wall between himself and the situation. This is expressed both in the typical bodily gestures of despair (crumpling up, covering the eyes with the arms,[19] etc.) (Figure 16) and by a sort of *encysting* (Figure 17) of the self: the child becomes obdurate.

State of Tension. The opposition of the two field forces in a conflict situation leads indirectly, as may be deduced in detail, to an increase in the total state of tension[20] of the child especially when there is an outer

[18]The principle, that self-control is not a consequence but a condition of obedience, finds a theoretical justification in these considerations (cf. 38).

[19]Cf. Lewin: appendix to Stern (41). The experiments of Fajans also show how in cases of great embarrassment the field forces drive the child, on the one hand, to turn away, to forget, to go (bodily or psychically) out of the field, or, on the other hand, to increased passivity.

[20]Tension is defined as the opposition of field forces in every direction.

barrier. (See the constrained situation with threat of punishment in Figure 11.)

Especially with children, in whom the psychological delimitation between self and environment is still slight (cf. *infra*), any increase in environmental tension is usually immediately reflected. This sensitivity may be seen in the fact that a tearful or a cheerful mood in the environment, travel preparations, the mother's bad humor, or any other excitement usually transfers to the child even when every effort is made to conceal the circumstances from him.

In the simplest case, an increase in the general state of tension is expressed by *restless behavior* (*Unruhehandlungen*). Restless behavior is a diffuse, undirected discharge of tension which, in conjunction with the directed forces of the particular situation, may culminate in *affective* outbursts such as fits of rage (12).

The basic case of restless behavior is unambiguously clear in the infant, and has very similar forms in pleasant and in unpleasant expectancy. If one holds out a rattle or nursing-bottle near the baby (the psychological situation corresponds to that shown in Figure 7), he stretches with arms, legs, and mouth in the direction of the valence. He does not remain calmly in this position, however, but begins to wave his arms and legs about.

With somewhat older children the *least* intense form of restless behavior, corresponding to an increase in the general state of tension, is a rapid change of occupation. An example: a three-year-old child in a Montessori kindergarten was very fond of drawing, but one day the director was unable to supply the requisite paper. Thereupon there occurred a number of varieties of *substitute behavior,* e.g., the child caressed the pencils, watched the drawing of older children, etc. Finally the child took up other occupations, but the average time he stayed with them was only 3.5 minutes as against 14.6 minutes on the preceding and 12.3 minutes on the following day. The increased tension resulting from the impassable barrier between the child and his goal had thus produced a fourfold increase in the frequency of his changes of occupation.

Ucko has demonstrated an analogous increase in frequency of change with older children in an experimental investigation of similar situations.[21] In addition, the increase in tension made the occupation more superficial.

Although marked restless behavior is essentially a diffuse discharge, its *form* depends upon the topology of the particular situation. For example, if the restless behavior is produced by the fact that there is a barrier between the child and the positive valence, the restless movements occur that so far as possible there is *no increase* in the child's distance from the positive valence. In other words, the restless movements occur in the *line of equilibrium,* i.e., when approach is prevented by a barrier, they take a direction perpendicular to that of the field vector.

[21]In these experiments the tension was produced by interrupting the child in his favorite occupation.

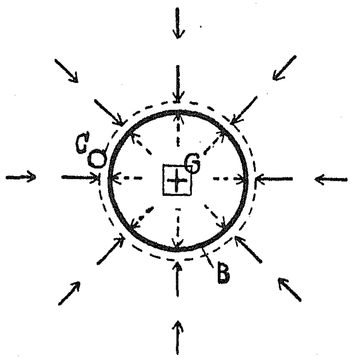

FIGURE 18
→ Driving force corresponding to the goal (G)
→ Restraining force corresponding to the barrier (B)
- - Line of equilibrium
(From K. Lewin's "Vectors, Cognitive Processes, and Mr. Tolman's Criticism." *J. Gen. Psychol.*, 1933, **8**, 323.)

In the case of the child who has difficulty in sitting down on a stone (cf. Figure 5) this may lead to circling the stone. If a sufficiently strong positive valence is enclosed by a circular fence (F, Figure 18), the restless behavior (apart from actions in the direction of the valence) may take the form of circling the barrier (34). If, on the other hand, the child is *inside* and the valence *outside* the circular barrier, the typical behavior is a very slight oscillation along the side toward the valence (Figure 19).

Induced Valences

As already mentioned, the valences correspond in part directly to the momentary needs of the child. A positive or negative valence may, however, be *induced* in an object or event by other environmental factors. This fact is of special importance in children.

Social Fields. It is a fundamental fact of childhood that the child's environment is not subject to his own control. The child faces a host of demands and difficulties. These requirements and difficulties arise, on one hand, from physical facts of the environment and the limitations

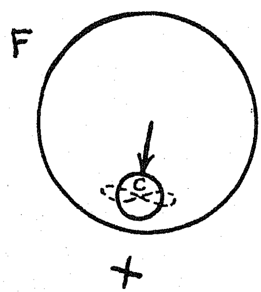

FIGURE 19

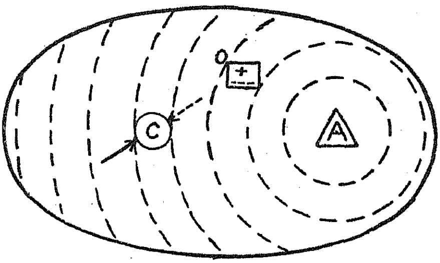

FIGURE 20
—> Induced force

of his own abilities: an object that the child wants to lift proves to be too heavy, a staircase down which he wants to crawl too steep, the pencil does not go over the paper as it should. Still more important are *social* factors, especially the authority or power of adults and of other children.

In the life of the neonate these social powers are first effective as sheer "physical" mastery (the child is bathed, dried, made to drink, etc.). But very soon their influence upon the child's *psychological* environment acquires increasing significance. The adult "forbids" or "permits" the handling of certain objects, characterizes certain behavior as "good" or "bad," praises and blames.

For the infant of a few weeks or months the valences depend essentially upon his *own* needs and their momentary condition. If he does not want a food he cannot be moved by psychological means to eat it.[22] He simply spits it out. With the older child the possibility of influencing him by psychological means is disproportionately greater. The disagreeable act may be imbedded in a game, in another *action unity*, and its meaning (and hence its valence) thereby radically changed.

The possibility of direct influence is correlated with the increasing psychological reality for the child of social facts, especially of the powers of others.[23] Many objects in the environment, many modes of conduct, and many goals acquire a positive or a negative valence or the properties of a barrier, not directly from the needs of the child himself, but through another person. This *"induction"* may be brought about by an expressed prohibition or command. More important, however, is the effect of example, i.e., of that which the child sees characterized by the behavior of adults as positive or negative for them. Even the very young child usually has a very fine sensitivity to social evaluations and forces.

The negative valence of a forbidden object (*O*, Figure 20), which in itself attracts the child, thus usually derives from an inducing field of force of an adult (*A*). If this field of force loses its psychological exist-

[22]Apart from simple distraction.

[23]Dynamically considered, these spheres of influence constitute *fields of force* for the child.

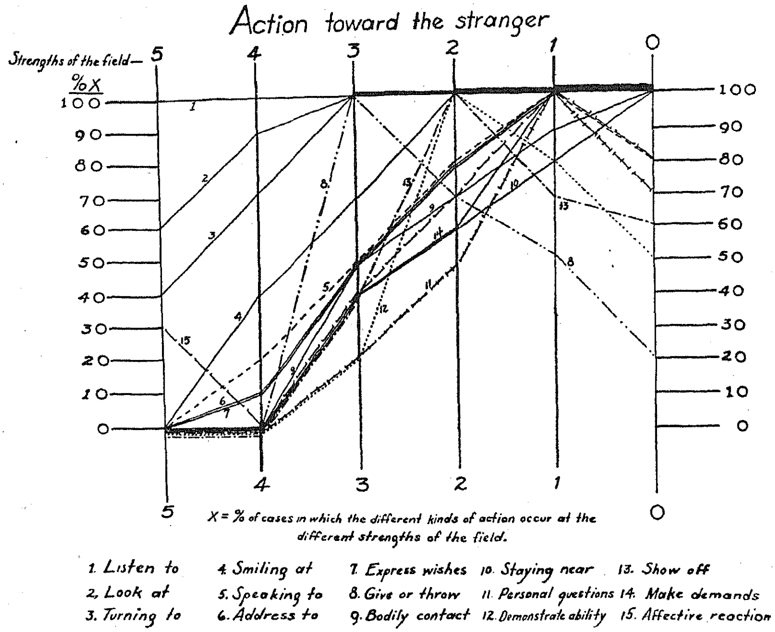

FIGURE 21

ence for the child (e.g., if the adult goes away or loses his authority) the negative valence also disappears.

In addition to the sphere of power of the adult, the behavior and spheres of power of other children or of a group of children are of critical importance for the kind and strength of induced valences.

The strength and extent of the fields of force of other people in the child's environment vary greatly, depending especially upon the economic situation, the character of the parents, the number, sex, and kind of children in the family and among his friends.

As a rule, the domain in which the child's environment is "free" (that is, essentially, dependent only on his *own* sphere of power) is relatively small. Too strong or too extensive alien spheres of power may lead to a real oppression of the child or to a particularly violent revolt. This is equally true in cases of too great strictness and of too great fondness. In either case the child has not enough life-space in which the valences and other dynamic properties of his psychological environment may be determined by his *own* needs. Wiehe (46), in an experimental investigation of the effect of a *strange* room or a strange person, distinguishes various degrees of strength of such a field, which degrees can be correlated quantitatively with distinct kinds of behavior, among others with the different kinds and degrees of approaches to and withdrawals from a strange person (Figure 21). The degree of strength of such a *social field*

of force is, excluding the individuality of the child and of the stranger, a function of the spatial distance of the strange person, the duration of his presence and his behavior. The strongest degree of pressure is expressed by the child's becoming motionless; a somewhat weaker, by crying and a tendency to run away, where possible, to the neighborhood of the mother or to another field in which the child feels at home. In the other actions of the child also a very strong pressure of strangeness (*Fremdheitsdruck*) evokes inhibited, a somewhat weaker pressure over-excited or over-emphasized, behavior. Only a further reduction of the pressure leads to a natural free behavior.

As an example of the effect of alien fields of force upon the child, let us consider the significance of the level of the external demands made upon him. Experiences of success and failure have, as Adler correctly emphasizes, an extremely marked effect upon the child's encouragement and discouragement, and hence upon his later performance. In experiments on success and failure with three- to four-year-old children Fajans found the following: If one distinguish four grades of activity (from very active to very passive), the child's activity on the same act may be reduced three grades by failure.[24] On the other hand, the activity of passive children could be increased by about the same amount. The effect upon the general self-consciousness is also quite considerable.

Hoppe (19) has shown that the occurrence of success and failure experiences depends upon the momentary "level of aspiration" (*Anspruchsniveau*), and that this level of aspiration is in turn related to the *ability* of the individual; with "quite too hard" and "quite too easy" tasks no experience of success or failure occurs. The child, for example, has no essential experience of failure when it cannot do something that only adults or much older children can do. Nevertheless, the level of aspiration is by no means determined *solely* by the ability of the individual. On the contrary, a level of aspiration decidedly above (or below) the child's real ability may be produced by the demands of adults or by the performances of comrades. For this reason there may develop a "feeling of inferiority" (or of superiority) which may be severely prejudicial to the child's general conduct and actual achievements.

Fajans found that the effects of failure could be materially reduced by a verbal "consolation" of the child (Figure 22). Here again the significance of the social field for the consciousness of self is evident. The offer of a *substitute satisfaction* (*Ersatzbefriedigung*) is even more effective than such consolations. Even for children of from six to nine months, success or failure changes the degree of activity and the duration of action toward the goal. But at this age the repetition itself, after a success, leads to a diminution in the duration of actions toward the goal (Figure 23).

[24]This holds chiefly for repetition of the same act within a certain interval of time. Adams (1, pp. 41, 47, 92, etc.) has reported marked reduction in the duration of activity with failure of cats in puzzle boxes.

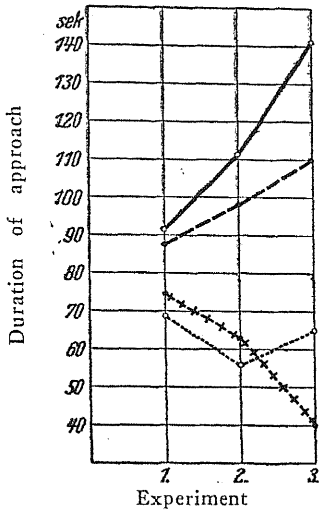

FIGURE 22

COMPARISON OF EFFECTS OF SUCCESS, CONSOLATION, SUBSTITUTE SATISFACTION, AND FAILURE UPON THE DURATION OF APPROACH

———— Success with simultaneous encouragement. Increase of duration of approach (from first to third experiment) = 48%.
- - - - - - Success. Increase of approach = 25%.
.... Substitute success. Diminution of approach = 6%.
++++++ Failure. Diminution of approach = 48%.
(From S. Fajan's "Erfolg, Ausdauer und Aktivität beim Saugling und Kleinkind." *Psychol. Forsch.*, 1933, **17**, 290.)

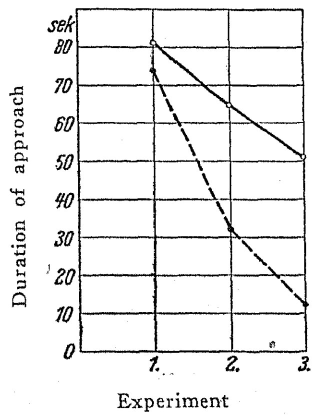

FIGURE 23

THE EFFECT OF SUCCESS AND FAILURE ON THE DURATION OF APPROACH IN INFANTS

———— Success
- - - - - Failure

(From S. Fajan's "Erfolg, Ausdauer und Aktivität beim Saugling und Kleinkind." *Psychol. Forsch.*, 1933, **17**, 278.)

Jucknat (22*b*), in an experimental investigation of some hundreds of school children, found that success and failure in one region may, under certain circumstances, change the level of aspiration in other regions: namely, when the two regions have sufficient dynamic connection and when the child's goal level in the region concerned is not too firmly fixed.

Means and Substitutes. An object or event possessing special emphasis may also, like a social field, induce an effect upon the environment.

A strongly accented goal so transforms the situation that practically all objects acquire a reference to this goal.[25] A building block that has just been a locomotive for the child becomes a hammer when it is desired to drive a stick into a hole. An object that becomes a "*tool*" may thus possess a derived valence. In the same way a bench may have the properties of a *barrier* in front of one goal or of a *means* to another, perhaps to climbing on the table (12, 27). Other environmental facts acquire the character of either a means to the goal or a barrier from it.

Another effect of the general "directedness" of the environment upon a chief goal is the occurrence in certain cases of *substitute goals* (*Ersatzziele*) (12).[26] Substitution plays a large rôle in childhood, probably larger than in adults. A child that would like to stroke a dog, but is afraid to, may stroke instead the child holding the dog (35). The adult usually employs the possibility of satisfying the child with a substitute, of diverting his wishes to a substitute goal, in the most various ways. As a rule, such a procedure creates less friction than a prohibition of the desired act. A frequent consequence of a prohibition (by reason of certain total structures which cannot here be discussed) is an implicit or overt counter-reaction, the so-called negative behavior of the child, which is the more fundamental in that the whole psychological emphasis of the desired act is considerably enhanced by the adult's prohibition.[27]

Such processes are very often significant in "pretending" or "play acting" behavior. A child would like to strike another child but contents himself with a threat; he would like to throw a ball very high and makes an exaggerated gesture.

With certain children, those Lazar has called "gesture children," the tendency to substitute a mere gesture for a real performance or a serious action is so strong as to constitute an essential character trait.

For children in general, the serious and the playful, reality and make-believe, are much more fluid, less sharply distinct than for adults. This fact is related to a property of the psychological environment which we must discuss briefly.

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[25]This is not merely an extension of an agreeable character to a larger field. On the contrary, quite different, both positive and negative valences and other kinds of shifts may be induced in surrounding objects by a positive valence.

[26]We are not here concerned with the theory of substitution which plays an especially important part in Freudian theory, except as it touches the question of *environmental* forces.

[27]It is possible that the proposition that "action and reaction are equal" holds also for psychological dynamics.

Strata of Reality in the Environment

The psychological environment of the adult shows a rather marked differentiation into strata of various degrees of reality. The plane of reality may be characterized briefly as the plane of "facts" to which an *existence independent of the individual's own wishes* is ascribed. It is the realm of realistic behavior, of insuperable difficulties, etc.

The more unreal planes are those of hopes and dreams, often of ideology. A stratum of greater unreality is dynamically characterized as a more fluid medium (4*a*). Limits and barriers in such a stratum are less firm. The boundary between the self and the environment is also more fluid. In a plane of unreality "one can do what he pleases" (12).

A complete description of the psychological environment must always set forth the structure not only of the level of reality but also that of the levels of unreality. If conditions on the plane of reality become too disagreeable for any reason, e.g., as a result of too high tension, there arises a strong tendency to go out of the level of reality into one of unreality [flight into dream, into phantasy (37), or even illness].

These facts hold in principle equally for the adult and for the child. Nevertheless, it is characteristic of the child's psychological environment (*a*) that the differentiation of various degrees of reality is much less marked, and (*b*) that transitions between the levels of reality and unreality occur much more easily than in adults.

The psychological environment of the small child can be characterized neither as a real nor as an unreal world, but the two strata are still relatively undifferentiated. Jaensch (21) and his students have shown for sensory psychology that the eidetic images (*Anschauungsbilder*) of children have the properties still undifferentiated of both the perceptions and the imaginings of adults. Piaget (39) has shown that the child's conception of the world, especially his ideas of causation, is still essentially "magical" and "animistic," that name and thing, act and magic word, are not yet clearly separated. (Cf. also 25.)

These properties of the child's perceptions and "intellectual" view of the world are only an expression of the general fact that in the child's psychological environment the differentiation between the levels of reality and unreality is still slight. This fact is further displayed in the peculiar seriousness of the child's *play*. From it derives the relative lack of distinction between wish and reality that is expressed, for example, in the very tenuous distinction between "falsehood" and "truth" (40). The great "suggestibility" of children is related to the same fact. For not only are the child's psychical processes closely dependent upon its present physical condition (e.g., illness), but, which is more often overlooked, the reverse also holds. Bodily condition may be very greatly influenced—especially in children—by the psychological. Thus it is that a small child's pain ceases when one "blows on the spot," that the horse may be "gone" when someone "throws him out the window."

The relatively slight differentiation between strata of reality and of unreality may still be noted in puberty: sometimes besides the real life a second life of phantasy is led for years, the events of which have the greatest significance for the child. Even for adolescents ideologies still in general possess much more real forces than for adults.

It would, of course, be false to believe that a differentiation between real and unreal strata is completely lacking in the child.[28] This is primarily true in the field of his real needs, both somatic and psychological. Even though the child may, under certain circumstances, be satisfied with an imaginary sweet instead of a real one, or treat a piece of wood better than a real doll, there are still very early indications of differentiation, at least in many respects, between reality and unreality. Schlossberg (39*a*) found that such an "unreal" object is accepted as a substitute only when the child is in a "play situation."

Play. The following circumstances constitute in my opinion the foundation for a dynamic theory of play: whether a given behavior (e.g., "game X in the sand box") is to be characterized as playful or non-playful cannot be determined from the standpoint of the adult but solely in terms of the child's own life-space. The fundamental dynamic property of play is that it has to do with events which belong in one respect to the *level of reality*, namely, in so far as they are "activities" visible also to other persons (as against day-dreams, for example). But at the same time play behavior is much less bound by the laws of "reality" than is non-play behavior: both the goal setting and the execution are in much greater degree subject to the pleasure of the person. This dynamic fluidity, in respect to which the play field approximates the dynamics of unreality, is evident, among other ways, in the changeableness of the meaning of things and of the child's own person (playing rôles) which goes far beyond what is possible in the level of reality. The play field is hence a region more or less limited as regards reality which shows even in its content a most immediate relation to the unreality of air castles and wish ideals (37).

The different forms of play vary rather considerably in the degree of their dynamic fluidity and the "rules of the game" may be so strict that the game may, dynamically, approach the rigidity of reality.

A strong tendency to go out of reality into unreality occurs, especially when an overstrong pressure dominates the former.

The course of differentiation between reality and unreality in childhood depends not only upon the individual characteristics of the child, but also in essential ways upon the situation and lot of the particular child. Among proletarian children this stratification usually develops earlier (16). So early and sharp a separation of reality and unreality seems to be unfavorable to the child's development. Important as a sufficiently clear separa-

[28]Piaget's thesis may have to be limited even for the child's "intellectual" concept (cf. 20 and 7).

tion of these planes is, the *kind* of relation obtaining between them remains decisive for, among other things, all creative behavior, and determines whether the ideal goals, which belong dynamically to the level of unreality, more or less directly condition behavior in the plane of reality.

Boundaries of the Self

Closely related to the slighter differentiation of the child's psychological environment into real and less real or unreal planes is a second factor: for the child, the boundary between the self and the environment is less defined than for the adult. This circumstance is of critical significance to the operation of the environment upon the child.

The individual is dynamically a relatively "closed system." How strongly the environment operates upon the individual will therefore be determined (apart from the structure and forces of the situation) by the functional *firmness of the boundaries* between individual and environment. The internal structure of the *child* individual is characterized dynamically by a relatively slight differentiation among the psychological regions (*Bereiche*) and by slight functional firmness in the boundaries of the various psychological systems.[29]

In other words, the child, to a greater extent than the adult, is a *dynamic unity*.[30] The infant, for example, acts first with its whole body and only gradually acquires the ability to execute part actions (32).[31] The child learns only gradually to separate out voluntarily certain parts of its environment, to "concentrate."

Analogous to this relatively slight delimitation among the various inner psychological systems, the functional firmness of the boundary between his own person and the psychological environment is also in general less with the child than with the adult. This is expressed, for example, by the fact that the "I" or self is only gradually formed, perhaps in the second or third year. Not until then does the concept of property appear, of the belonging of a thing to his own person (41). The same relative indistinctness of the limits of the self is apparent in the fact that external impressions touch the central nucleus of the child's personality decidedly more readily than with adults. Conversely, needs, or other tensions of the inner psychological systems, burst through very easily in the form of impulsive behavior and uncontrolled affective demonstrations. (Cf. the example on pages 609 and 610.)

The slighter firmness of the boundary between self and environment has a direct bearing upon the slighter separation of real from unreal strata (cf. page 617). For it (the former) implies that the psychological environ-

[29]This is not the place for a more comprehensive discussion of the internal structure of the personality.

[30]A "strong *Gestalt*" in Köhler's sense (cf. 28).

[31]Coghill's (9, 10) important researches have shown that in embryological development even the reflexes are formed by a gradual differentiation of reactions which originally involved the whole organism.

ment of the child is more intimately connected with and responsive to his momentary needs and wishes.

The functional firmness of the limiting layer between the child and the environment varies greatly, even in the same child, in different *situations* and toward different persons. This is equally true of the child's receptivity or inaccessibility toward external impressions, and to the ease with which internal states, especially tensions, come to expression.

It has been found in the course of psychopathological investigations that in certain circumstances children are more readily induced to talk openly of personal matters when they are naked.[32] Children also are usually inclined to talk more freely about experiences otherwise kept back when they are going to bed in the evening.[33]

The functional firmness of the wall between the self and the environment depends not only upon age but also upon the individual characteristics of the person. It is especially slight among certain psychopathic children (31). The cause of this may be a greater fluidity and at the same time a slight (relative to chronological age) degree of differentiation of the person. This fluidity is also apparent in the dynamics of the environment, so far as the latter is psychologically determined. Feebleminded children are also characterized by a relatively slight degree of differentiation of the person (37*a*).

As distinguished from the above-described psychopathic children, certain types at least of the feebleminded are characterized by a slight fluidity of the psychic systems. This inflexibility leads to an "either-or" behavior that is evident in the sphere of the psychology of the will in an especially strong fixation of certain valences and modes of behavior (stubbornness, pedantry). The immobility of the psychological systems and of the psychological structure of the environment is at the same time a decisive dynamic cause for the difficulties of these children in intellectual fields.

Even when a marked separation of the self from the environment has already occurred there may exist a particular dynamic union between the self and other persons, for example, the mother or some friend. This union may be expressed in various ways, among others by the child's behaving worse with the mother than with other people, by outspoken protest against even a temporary absence of the mother, by turning to the mother—"hiding behind her skirts"—in any disagreeable situation. In such cases the presence or absence of the mother changes the total structure of the psychological environment very essentially, especially the child's feeling of security or insecurity. As a consequence of the close psychological

[32]James has emphasized the close relation between clothing and the psychological person as a social being. It is hence (and on other grounds) understandable that under certain circumstances nakedness diminishes the firmness of the psychological wall between child and environment.

[33]Cf. (25). The greater frankness of children shortly before going to sleep may be related to a beginning of the partial dissolution of the boundary between reality and unreality that is characteristic of sleep and dreaming. [Cf. also (14).]

relationship between the mother and the child's own person, the real abilities of the mother, her effectiveness as against the things and persons of the environment, have for the child the functional significance of an extension of his own security and power against the environment. A departure of the mother thus means to the child a weakening of his strength against the environment.[34]

The animistic character of the child's view of the world may also be related to the fact that his psychological environment generally has "*personal* fields of force" as prominent dynamic features of its structure.

Not only other persons but other *objects* may have a close psychological relation with the self of the child. To the "I" in this sense there belongs not only the child's own body but certain toys, a particular chair, etc. Such objects are dynamically somewhat like his own body in that they represent points of special sensitivity to invasions by environmental forces. Whether an object belongs to the self or to the outside world depends, according to Wiehe (46), among other things upon the present *needs* and internal tension systems of the child, and changes with them. It happens, for example, that the destruction of an incomplete production of the child, in consequence of its belonging to the self, is felt by him as a violent invasion; while destruction some time after completion of the task leaves him quite unaffected. An internal discharge of tension is usually accompanied by a loosening of the appurtenances of the self, and this is especially marked in children.

The Influence of Environmental Forces on Development

The same factors that are critical for the momentary situation are also characteristic of the *total milieu* of the child over longer periods of his life. Their effects upon the development of the child's personality and his whole behavior are similar to the effects of the forces described in the momentary situation upon his momentary behavior. Particular features of the environment are usually less important than its *total character* in determining its effect upon development and, more particularly, upon the rate and mode of differentiation of the child's personality. Overly harsh or severe surroundings may lead to the child's encapsulating or insulating himself from the environment. The child becomes stubborn and negativistic. (Cf. pages 609 and 610 *supra*). Optimal environmental conditions, e.g., optimal tension level, vary considerably with different individuals. It is a well-known fact that infants and young children who grow up in an institution generally show a slower development in many respects than children who grow up in a family.

It is already clear from the circumstances just discussed what great significance a *change of environment* may have for the child's development. The so-called difficulties of training are not infrequently related to the

[34]The tendency of children to take a doll or some favorite toy along to bed is another expression of the close union of these objects with the self.

particular requirements of the parents, to their characters, and to the way they get along together. They disappear as soon as the child has been for some time in a suitable environment. To be sure, the difficulties usually begin all over again after a return to the old environment.

Enuresis is not infrequently treated successfully by changing environment (47). Of course, the improvement is often only temporary. Grisch describes the disappearance of a *voluntary dumbness* with change of environment.

Up to now we have been describing the effects of the *present* situation upon development. These effects cease with a change in the situation. Nevertheless, the operation of the environment always has as a consequence a more or less marked change in the individual himself, and thus changes his "basis of reaction" to all later situations. This influence of the present situation upon *future* possibilities of conduct, which is particularly significant to development as a process considerably extended in time, is due not only to the child's acquisition of certain intellectual "experiences" but, above all, to the fact that his whole person is changed in certain specific ways.

This indirect operation of present upon future situations may be expressed in favorable as well as in unfavorable ways. Its importance is especially great in view of a condition which might be termed the "circular causal relation [*"zirkuläre Rückkoppelung"*] between self and environment." A feebleminded child, for example, is at a disadvantage among his comrades in *two* ways. In the first place, he cannot do a task (e.g., corking a bottle, writing with a pencil, or some other such task) even when the conditions are so arranged as to be actually the *same* for the feebleminded child and his normal playmate (e.g., when both are gotten to grasp the pencil or cork and bottle in the same way). In practically all cases in practical life, however, there is a second difficulty: when the more intelligent child is given a task, he knows that he must look for the mode of manipulation that involves the least difficulties under the conditions given. The less intelligent child has a narrower field and sees less into the internal relations of the environment. He does not find out, perhaps, that it is more convenient to hold the bottle as near the mouth as possible. More generally, he is less likely to discover the easiest way of solving the problem.

The less intelligent child is thus not only less able, but the actual demands made upon him by apparently the same problem are usually really greater than those made upon the intelligent child. The poorer solution of the weaker child thus usually has the double character of an *"inferior performance"* of a *"more difficult task."*

If, now, the less gifted child experiences a failure, he will, as we have seen, attack subsequent problems less intensely. The increased fear of failure creates, wholly apart from the child's inferior ability, a situation psychologically still more unfavorable. In the new situation the already weaker child will thus fail or give up all the more readily. He stands

usually before a (psychologically considered) harder task, and his total situation is, owing to his earlier experiences, more unfavorable.

Quite analogous cumulative series due to this vicious circle may be seen in psychopathic children or in other children that have difficulties in social groups. The over-excitable or socially disagreeable child is not only less competent in his social situation, and thus makes his task the harder, but also the other children reject him, drive him to a defensive attitude, etc. The child soon gets himself into a social situation, originating perhaps in some quite trivial conflicts, that would tax the capacities of a child of high social endowment.

Similar developments of a circular causal relation between capacity and environment are basic, for example, to stammering (18). Conversely, not the least advantage of the gifted child consists in the especially *favorable environmental* conditions that he usually creates for the future.

I consider it one of the fundamental tasks of pedagogy so to constitute the situation of children in difficulties that the severe injuries usually occasioned by the circular causal relation may be avoided or undone. For here at least lie genuine pedagogical possibilities which do not require changing the child's "abilities."

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CHAPTER 15

SEX DIFFERENCES

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In former days it seems to have been rather generally believed that in mental ability the male was superior to the female. There was justification for this point of view in that men had far surpassed women in almost every line of literary, scientific, aesthetic, political, and practical achievement. It was only occasionally that some woman broke through the ranks to stand near the top on an equal footing with man. Even in such cases the excellence of her performance was approached by a greater proportion of the opposite sex than of her own sex.

With the advent of more precise means of measurement through mental tests and achievement tests, it began to be apparent that achievement is a complex only partially determined by the level of mental ability. It also became apparent that boys and girls differed very little in intelligence, in so far as it could be measured, or in special mental abilities or disabilities.

For a while, then, it was contended that the male was more variable than the female. Although it was conceded (on the basis of an accumulation of evidence) that the central tendency was about the same for the two sexes, it was held that the extreme ranges were occupied by males. The "genius" levels of intelligence and extreme mental deficiency were thus supposedly represented by the males, while the females were grouped more closely around the central portions of the distribution. When a careful scrutiny of the evidence was made, doubt was again thrown on current conceptions. It was shown that there was little clear evidence for believing that one sex was more variable than the other in mental abilities, at least to any appreciable degree.

Interest in the subject of sex differences, however, has not subsided with these negative findings. The inquiring mind seems ever to be alert for the uncovering of some difference of magnitude that has heretofore escaped precise measurement. Common observation seems to tell us that boys and girls are different. Perhaps the aspects of mental life that have been measured are not the crucial ones in which the real differences may be expected. Consequently, periodically the psychologist takes stock of the ever accumulating evidence.

There are a number of difficulties in the way of an accurate accounting of differences due to sex. In discussions of sex differences a clear distinction between found differences and fundamental innate differences is not often made. On the former there is a mass of material available; on

the latter there is almost nothing that is adequately demonstrated. Since psychologists are accustomed to presenting results for the two sexes separately, one must read almost every investigation in child psychology to gain a complete knowledge of the differences that have been found. As to why these differences exist, how they came about, how they develop genetically and under what conditions, a few authors here and there have made slight attempts to ascertain or have hazarded guesses. Controlled experiments attempting to measure differential conditions and their influence upon differences between the sexes are almost entirely lacking.

It is difficult to tell whether differences found are representative or are affected by the selection of the particular cases studied. To secure a random sampling that is equally representative of boys and girls, it seems desirable to plan the whole investigation carefully from this standpoint. Very few investigations have been so planned. A comparison of boys and girls in high school, for example, might be influenced by selective factors that cause a greater proportion of one sex (probably girls) to remain in school. The number of children included in many investigations is inadequate for sex comparisons. Not only should there be an adequate number of cases to establish a stable mean or median of an age group, but the distribution of ages within the age groups should be approximately even for the two sexes wherever growth may be expected within an age group. This is particularly crucial at the younger ages.

In addition to these difficulties, there is the problem of selection of test items whenever a score based on a battery of tests is used. It is possible to get what seems to be a fundamental difference by unintentional selection of test items with which one sex is more familiar than the other. Seeming differences in intelligence might be due to the inclusion of a disproportionate number of the kind of subtests in which one sex excels.

If this chapter were limited to those investigations which have found statistically significant differences between the sexes, there would be little to report. The general trend of present opinion seems to be that individual differences in mental abilities within the same sex far outstrip the small differences found between the two sexes. However, it may be of interest to note those abilities and characteristics in which small, even though insignificant, differences have been found by a number of independent investigators. In this chapter, therefore, an attempt has been made to indicate those aspects of mental development on which a sufficient number of investigations or sufficiently extensive investigations have been made to justify a statement of trends. Small differences may be more crucial than is sometimes believed.

Goodenough (81, p. 447) feels that there is a "possibility that very slight original differences in ability may operate as directive agencies through which an entire system of interests, preferences, habits, educational and vocational choices may be built up. Conditions which are themselves transient may nevertheless produce permanent results." Cornell (46, p. 226) also came to the conclusion that the accumulation of small

differences may be very important. She feels that the greater school retardation of boys may be due to a combination of small divergences which produce a rather large total effect. This is discussed somewhat more fully in the section on *Education*.

Although approximately five hundred references reporting differences between the sexes have been covered in this chapter, the sampling of literature is admittedly incomplete. Since there is little evidence on the amount that social, cultural, and other environmental influences may condition differences, it has seemed best to limit the references included to American investigations.

Differences in Intelligence

Girls tend to have slightly higher mean or median scores on tests of general intelligence. These differences are rarely statistically significant. At the infant and preschool ages there is clear superiority of the girls (as indicated by slightly higher scores in every investigation covered regardless of the test used). At the infant level the tests for which these differences have been found include the baby tests standardized under the direction of Charlotte Bühler (although the differences are extremely small here) and the Linfert-Hierholzer scale. At the preschool levels they include the Kuhlmann-Binet, Stanford-Binet, Merrill-Palmer, and Detroit kindergarten tests.

From an analysis of the subtests of the Kuhlmann-Binet scale, Goodenough felt that the selection of test items was such as to favor girls of preschool age; there was a number of tests dependent upon memory and tests of linguistic or verbal nature in which girls excel, but not a corresponding balance of items in which boys might be expected to excel. This explanation seems plausible in regard to the Binet tests, but is somewhat less applicable to those scales which are not of the verbal type.

The crux of the matter, in so far as general intelligence of the sexes is concerned, is not whether one sex is better able to do particular subtests but how adequately the scale measures the whole of intelligence. The fact that a scale contains a number of subtests in which girls excel does not necessarily mean that it is overweighted with these tests; it is overweighted only if the proportion of these tests to the total is higher than it should be from the standpoint of intelligence *per se*. If the proper proportion for determining intelligence has been maintained in existing scales, then girls are slightly superior in general intelligence. If, however, the scales are overweighted with the type of subtest in which girls excel, then girls are not superior in general intelligence even though they receive higher scores. There seems to be no conclusive answer to this question.

[Baldwin and Stecher (12); Goodenough (81, 83); Johnson (110); Linfert and Hierholzer (130); McGraw (148); Nelson (161); Stutsman (203).]

At the school ages there is also a tendency for girls to do better on intelligence tests than boys, although some investigators have found boys

superior. In some cases there are quite evident selective factors in the populations studied. An example of this is found in a comparison of boys and girls in a manual training high school where the median intelligence was the same but the boys averaged five months older chronologically than the girls. Since the comparative ages and distribution within ages are often not expressly given and other selective factors not noted, it is difficult to make an evaluation of the differences found from these standpoints. The scales used include a wide variety of group and individual tests.

[Aden (1); Bassett and Porteus (15); Book (26); Book and Meadows (27); Brooks (32, pp. 134-173); Broom (33); Commins (44); Cornell (46); Cuneo and Terman (50); Davis (52); Division of Psychology, Institute of Educational Research (56); Easby-Grave (61); Garth and Whatley (71); Goddard (79); Hanske (91); Hartshorne, May, and Shuttleworth (95); Hirsch (101); Johnson (110); Jones (111); Madsen (135); Mead (152); Merriman (153); Mitchell (156); Paschal and Sullivan (169); Pintner (176); Pressey (180); Pressey and Pressey (181); Strong (202); Terman (206, pp. 68-72); Uhrbrock (217); Wentworth (235); Whipple (236, 237); Young (249).]

There is some feeling that boys near the end of high school are superior in intelligence to girls. At least one investigation has pointed out the possible selective factors in the populations studied in favor of the boys. Boys who remain to complete high school may be somewhat more highly selected than the girls who remain. Whether these same selective factors account for differences found in the other investigations or whether boys of average and above average intelligence maintain a higher level of intelligence than girls as they grow older (a theory supported by some) is an intriguing question on which there is only partial evidence. There is some evidence that boys in institutions for the feebleminded decrease in IQ more than girls. If a "change of rate" theory is tenable, it apparently works in reverse fashion for the two ends of the distribution of intelligence.

[Baldwin (10); Baldwin and Stecher (11); Book (26); Book and Meadows (27); Burks, Jensen, and Terman (35); Division of Psychology, Institute of Educational Research (56); Gerberich (74, 75); Hirsch (101); Lund (133); Madsen and Sylvester (136); Minogue (155); Terman (207, 208); Thorndike (210).]

In attempting to locate a thousand children of "genius" level of intelligence, Terman found 116 boys to every 100 girls. At the high-school ages this ratio was raised to 212 to 100. This is a far higher proportion than can be accounted for by the excess of male births in the general population, which he estimates to be about 104.5 boys to every 100 girls. The ratio of boys to girls in the families of the "gifted" group was 119.5 to 100. "The true cause of the sex ratio," Terman (208, p. 54) says, "can not be determined from our data. It may be either variability or the differential death rate of embryos. Both of these factors may be involved and possibly others. Biased selection due to the method of nomination and

testing is probably not responsible." Also, "except for the non-excess of boys in the highest IQ ranges, the facts we have presented are in harmony with the hypothesis that exceptionally superior intelligence occurs with greater frequency among boys than among girls."

The proportion of boys to girls in the lower grades of intelligence seems extremely difficult to determine accurately because of biased selection. Differences in opportunity for survival outside of institutions, in attitudes of parents toward deficiency in boys and girls, and in factors other than intelligence that accompany extreme school retardation complicate an accounting of sex differences in these ranges. There are about twice as many boys as girls referred for examination as being the most deficient or backward in schools. It seems probable that girls not furnishing disciplinary problems are permitted to stay longer in the grades. When examined, however, there seems to be a slightly greater number of boys in the very lowest IQ ranges (below 35).

[Bridgman (30); Cobb and Hollingworth (43); Dayton (54); Hollingworth (105, 106); Murphy (160); Pintner (177); Schmitt (189); Wallin (225, 227).]

There is much controversy in the literature concerning the relative variability of the sexes in mental ability. In the material covered for this chapter there seems to be some slight support for the hypothesis of greater variabilty of boys. The case is by no means clear, however, the findings depending so much on the measuring instrument, the measure of variability used, the selection of the children, and the sex which obtains the higher mean or median score.

[Burks, Jensen, and Terman (35); Commins (44); Cornell (46); Division of Psychology, Institute of Educational Research (57); Henmon and Livingston (97); Hollingworth (103, 104, 106); Merriman (153); Pintner (177); Pressey (180); Pressey and Pressey (181); Terman (206, pp. 68-72); Winsor (242); Young 249).]

In correlations between intelligence of children and parental intelligence, education of parents, carpal bone area, dentition, height, and weight there have been no striking differences between the sexes.

[Baldwin (10); Brooks (31; 32, pp. 134-173); Cattell (39); Conrad and Jones (45); Freeman and Carter (68); Gates (72); Goodenough (82); Jones (112); Lowell and Woodrow (132); Murdoch and Sullivan (159); Prescott (179); Stalnaker (197); Willoughby (240).]

Specific Mental Abilities

Boys tend to excel in formboard performance and picture puzzles. Representative of these tests, applied at various ages from two to fifteen, are the Witmer cylinders, Wallin pegboards, Witmer formboard, Dearborn formboard C, five-figure formboard, mare and foal, triangle and diagonal, Seguin formboard, Rossolimo dissected pictures, Healy picture completion, Stutsman picture puzzles. Boys also excel in slot mazes.

[Baldwin and Stecher (12, pp. 170-174); Easby-Grave (61); Good-

enough (80); Johnson (110); Jones (113); McGinnis (147); Paschal and Sullivan (169); Stutsman (203); Wallin (223, 224); Wilson (241); Young (248).]

Girls usually excel in memory, the type of test material making some difference.

[Allen (4); Barlow (14); Book and Meadows (27); Boynton (28); Dietze (55); Easby-Grave (61); Emerson (64); McGeoch (145); Mead (151); Mulhall (158); Pyle (183, 184); Woolley and Fischer (247).]

Girls are superior in response to color in infancy (5½ to 24 months) as determined by reaching for colored discs in preference to gray ones. They are superior also in color discrimination, color card sorting, color naming, and the use of colors in designs at the preschool ages, and in color recognition in all of the school ages. The sexes vary somewhat as to the specific colors preferred. There is possibly a greater "pull" of color preference or positiveness of discriminative preference in boys.

[Baldwin and Stecher (12, pp. 170-174); Garth (70); Gesche (76); Hurlock (108); Katz and Breed (115); Lewerenz (128); Monroe (157, p. 97); Staples (198); Wagoner (220); Woelfel (244).]

Girls tend to excel in cancellation tests.

[Baldwin and Stecher (12, pp. 170-174); Haggerty and Kempf (86); Mead (151); Pyle (184); Woolley and Fischer (247).]

Language Development

In the early years girls are clearly ahead of boys in all aspects of language and speech development. In the investigations covered there was no instance where boys were superior, although a few reported no differences. These aspects include the age of beginning to talk, size of vocabulary, length of response, comprehensibleness of response, use of parts of speech, sentence structure, function of language, speech sounds, and stuttering. From a review of the literature, Travis reports that boys outnumber girls in stuttering in a ratio of from 2 to 1 to 10 to 1; he also states that the ratio changes with age, the greater the age the greater being the preponderance of male over female stutterers. At the school ages, girls seem to excel in such tests as word completion and dissected sentences. This language superiority is carried on into the college levels where girls make better scores in the English portions of objective tests. This is discussed further in the section on *Education*.

[Berry and Stoddard (19); Blachly (20, 21); Book and Meadows (27); Davis (51); Day (53); Gale and Gale (69); Holden (102); Magni (137); McCarthy (142, 143); Mead (150, 151); Paterson and Langlie (171); Smith (193); Sommer (196); Terman (208); Travis (214); Wallin (222, 226); Wellman, Case, Mengert, and Bradbury (234); Woolley and Fischer (247).]

Motor Development

Although it has not been clearly demonstrated, in the first few days of life girls seem to show slightly greater motility as measured by the amount

of activity recorded by stabilimeter techniques. Girls learn to walk at an earlier age than boys. At the preschool ages they are superior in buttoning ability and at the school ages they are possibly superior in tests of steadiness and in writing.

[Bagley (9); Bolton (25); Burnside (37); Gatewood and Weiss (73); Gesell (77); Hancock (90); Lee (117); McHale (149); Mead (150, 151); Pratt (178); Starch (199); Stutsman (203); Sunderlin (205); Terman (208); Tucker (215); Wagoner and Armstrong (221); Woolley and Fischer (247).]

In a few motor learning experiments at the preschool ages the boys have been somewhat superior in initial test, but the girls have made greater gains. Each of the investigations has used a different type of test and relatively small numbers of children. In view of the specificity of motor tests, even at the preschool ages, it seems hazardous to posit superiority of boys in general motor ability on the basis of these findings.

[Goodenough and Brian (84); Hicks (99, 100); McGinnis (147).]

Boys do better on most tests of mechanical ability, although girls may excel in certain types of tests. The authors of the Minnesota mechanical ability tests felt that differential opportunities for practice rather than innate differences accounted for most of the differences found between the sexes.

> "The nature of the sex differences disclosed sharply challenges prevalent opinion regarding the superiority of boys and men in mechanical ability. Seventh grade girls actually excel seventh grade boys in the Minnesota Spatial Relations, Card Sorting, and Packing Blocks tests. In the face of unequal social pressure exerted upon the sexes in things mechanical, this superiority of the girls is most striking. The only test in which boys and men clearly excel is the Minnesota Assembly test, such superiority undoubtedly being based upon greater opportunities for practice in manipulating mechanical contrivances. In the absence of such specific practice effects, as in all the other tests, the differences between the sexes tend to disappear. In short, boys and men are not definitely superior to girls and women in mechanical ability" (170, p. 283).

On the other hand, the authors argue that there are individual differences within a sex which have not been accounted for by their attempts to measure environmental conditions.

> "The failure of this attempt to discover environmental factors responsible for the undoubted individual differences in mechanical ability exhibited by these seventh grade boys places the burden of proof upon the person who rejects the hypothesis that these individual differences are in large part innate" (170, p. 301).

[Aden (1); Paterson, Elliott, Anderson, Toops, and Heidbreder (171); Stenquist (200).]

Physical achievement or "motor agility" test scores are usually higher for boys than for girls. It has seemed somewhat outside the scope of this

chapter to include references to the literature on this subject. The investigation of Bliss (24) is cited as representative of this field.

There seems to be no sex difference in preferential use of hands at the preschool ages, although the proportion of boys at the school ages who are left-handed may be greater than that of girls. There does not seem to be very good agreement among investigators, however, as to what criteria are acceptable for determining handedness.

[Ballard (13); Doll (58); Downey (60); Jones (113); Ojemann (164); Wallin (222, 226); Wellman (232).]

In tapping and tracing-board tests sometimes one sex excels and sometimes the other, depending apparently upon the particular selection of subjects and techniques used.

[Bagley (9); Bolton (25); Bryan (34); Gilbert (78); Hewes, Bonitz, Davis, Moore, Porter, and Turner (98); Johnson (110); Tow (213); Wellman (232); Woolley and Fischer (247).]

Variability findings in motor traits seem to depend upon the measure of variability used, the particular trait considered, and the selection of subjects.

[Gilbert (78); Hicks (99, 100); Johnson (110); Mead (151); Tow (213).]

Personality

More boys than girls are considered "problem" children and commit misdemeanors. Greater proportions of boys are considered problems at home or at school, are credited with misdemeanors by teachers, are referred to clinics, and show more behavior problems as measured by scores on the Olson behavior problem record and behavior rating scale. In Wickman's (239, p. 45) study, teachers reported for boys twice the frequency of tardiness, truancy, destruction of property, stealing, profanity, smoking, masturbation, interrupting, overactiveness, physical laziness, disobedience, defiance, cruelty and bullying, rudeness, meddlesomeness, acting smart, nervousness, enuresis, slovenliness, suspiciousness, and suggestibility. Very slight differences were reported for whispering, inattentiveness, tattling, stubbornness, temper outbursts, domination, overcriticalness, and unhappiness. Teachers "are particularly sensitive to the aggressive, overt forms of behavior problems, which characterize the behavior of boys" (239, p. 50). No particular differences were reported for shyness and oversensitiveness.

Cornell felt that boys were probably more positive in their reactions than girls (or at least impress their teachers that way). On school attitudes (a rating scale for industry, attention, interest, memory, and comprehension) girls received higher ratings.

[Anderson (5); Blanchard and Paynter (22); Blatz and Bott (23); Cornell (46); Haggerty (85); Murphy (160); Olson (166, 167); Phillips (174); Ward (228); Wickman (239).]

Boys seem to show greater overt expression. As early as the pre-

school ages this is manifested by overt behavior responses in a mental-test situation, ratings on extroversion-introversion, response to laughter-provoking stimuli (boys responding more with laughter and girls with smiles), number of questions asked apparently to satisfy a "felt need," amount of companionship reactions to others in a preschool play situation, and possibly frequency of evidence of anger. Boys in the elementary grades also seem to be rated more extrovertive and their school achievement more related to extroversion. The above examples are based on single investigations and the separate items need verification through additional research.

[Andrus (6); Hagman (87); Hendrickson and Huskey (96); Justin (114); Marston (139); Nelson (161); Ricketts (185); Washburn (230).]

There is some evidence that boys may respond more to external incentives. Investigators have reported either no differences or greater response of boys. It is possible, however, that this seemingly greater response is due to their lower initial test standing in relation to potential ability. Incentives and tests used have been praise, reproof, punishment, reward, success, and failure on motor energy exerted with a motivation-dynamometer; story, game, reproof, praise, party, and play on addition; praise and reproof on intellgence test scores; and rewarding with chocolate bars on multiplication. There are at least two factors that make it difficult to determine the true effects of such incentives: (*a*) the differential effect of uncontrolled incentives already operative at the time of initial measurement (such as the ordinary incentives in school work), and (*b*) the tendency for those starting on a lower level in reference to their maximum capacity to increase more than those who are nearer their maximum output at the beginning of the experiment, the latter having less reserve.

When boys and girls were confronted with the alternative incentives of working for self or for the benefit of the class group or others in the investigations of Hartshorne, May, and Maller, there was little difference in total "service" scores but a tendency for girls to be slightly more cooperative. The total score was based on electing to let scores in simple addition count for self or for class contest, doing addition alternately for self and for class record, electing to use class prize money for purposes ranging from philanthropy to division among selves, giving away to poor children all to none of a school kit given each child by "a friend of the school," collecting and preparing printed jokes and play materials for hospital children.

In spite of the small differences found in the test situations for "service," girls had the reputation of greater service. Pupils of both sexes rated girls higher than boys; teachers also rated girls higher. "The difference between the sexes in reputation . . . . is so much greater than it is found to be on the tests that one is inclined to believe that a sex prejudice may be at work which rates the boys lower than they really are and the girls higher than they really are" (94, p. 156). In total reputation scores boys were consistently and extremely more variable than girls.

At the preschool ages, girls are rated as showing more "motherliness" and as tending toward greater responsibility for others, although not differing from boys in a number of other social behavior traits.

[Berne (18); Chase (42); Hartshorne, May, and Maller (94); Hurlock (107); Leuba (125); Warden and Cohen (229).]

Girls may be slightly more resistant during mental tests at the infant and preschool ages. At the school ages results on suggestibility are contradictory. In "self-control," particularly in inhibition and resistance to distractions, girls make higher scores than boys. "There is no doubt at all," say Hartshorne, May, and Maller (94, p. 382), "but that the girls are genuinely better inhibited than the boys in the types of conduct included in our tests. In all tests in each population, the differences favor the girls." On those tests of persistence most like school work the difference was less for the children who were in the more progressive type of school. The "difference between boys and girls in power of inhibition is far less in the X population than in the other two, ... in the self and class persistence scores the X boys are actually superior to the X girls, and . . . . in general level of speed ability they more nearly approach the girls than in either of the two other populations" (94, p. 385). This divergence may be accounted for by "the tendency for boys of more progressive schools (perhaps because of selection) to be more nearly equal to the girls in school drive than in the general run of schools" (94, p. 385).

Girls had a higher reputation for inhibition and an "enormously" higher reputation for persistence than boys, even in the population where the boys had a higher test score. The "boys appear to have a lower reputation score than the tests would warrant" (94, p. 381).

[Chapman (41); Hart and Olander (92); Hartshorne, May, and Maller (94); Hartshorne, May, and Shuttleworth (95); Hurlock (109); Levy and Tulchin (126, 127); McGeoch (144); Otis (168); Rust (187).]

Throughout the preschool and school ages, girls apparently show more nervous habits such as nail-biting, thumb-sucking, finger-sucking, and protrusion of tongue. By existing scales for measuring nervous stability, there may be some tendency for girls to receive scores indicating greater nervous instability, but the evidence is somewhat contradictory.

[Burks, Jensen, and Terman (35); Hartshorne, May, and Shuttleworth (95); Mathews (141); Olson (165); Snyder (195); Terman (208); Viets (219).]

Girls show greater jealousy of other siblings than do boys. In a group of more than a thousand children who were living at home with one or both parents and who were studied by one clinic, about 15 per cent of the children were reported jealous. About two out of every three children reported jealous were girls.

[Foster (66); Ross (186); Sewall (191); Smalley (192).]

The decision as to which sex is higher in honesty seems to depend upon the particular population studied and the particular selection of tests. The

findings apparently can be reversed by making changes in these two respects. In the total score based on those aspects so far studied, girls were found to be significantly more dishonest than boys, although the sexes varied in superiority on specific tests. There seemed to be greater individual differences in integration of honesty among the girls.

Girls make higher scores on tests of moral knowledge, opinion, and attitude.

> "It appears on the surface at least that girls are more sensitive to both conventional and ideal social standards than boys . . . . . These differences . . . . . in moral knowledge are all the more remarkable in view of the fact that moral knowledge is highly correlated with intelligence . . . . . and yet there are no sex differences in intelligence. There is evidently something other than intelligence that determines the scores on these tests of one's knowledge of 'right' and 'wrong' and one's way of feeling toward the moral demands of life situations" (95, p. 119).

[Burks, Jensen, and Terman (35); Hartshorne and May (93); Hartshorne, May, and Shuttleworth (95); Tudor-Hart (216).]

Possibly boys are more variable than girls in personality characteristics. Variability seems partly dependent upon which sex makes the higher mean score as well as on the particular trait measured and the particular measure of variability employed.

[Croswell (49); Hartshorne, May, and Maller (94); Hartshorne, May, and Shuttleworth (95); Justin (114); Minard (154); Olson (166); Terman (206, 208); Whitley (238).]

Boys and girls differ in vocational choices. An example of these differences is found in the study of Lehman and Witty in which children specified the vocation they thought they would be most likely to follow. Teaching in kindergarten, for example, was checked by 341 times as many girls as boys, teaching in grades or rural schools by 149 times as many girls, teaching in high school by 11 times as many girls, and school principalship by 3 times as many girls. Boys and girls also differ in the games played at different ages. Choice of play occupation varies with sex as early as the preschool ages. On the basis of preference for games, Terman has devised a "masculinity index." He found gifted girls to be more masculine than a control group of girls.

[Anon. (7); Bridges (29); Caswell (38); Coy (48); Croswell (49); Foster (65); Lehman (118); Lehman and Witty (119, 120, 122, 123); Marshall (138); Masslich (140); McGhee (146); Terman (208); Van Alstyne (218); Whitley (238); Witty and Lehman (243).]

Boys and girls agree in finding their companions more preponderantly within their own sex. It is possible that very early there is little choice on the basis of sex. By four years of age, however, definite preference for the same sex is manifested and it is maintained through at least the early school years. Interest in the opposite sex may appear to a greater extent in girls at an earlier age.

[Burks, Jensen, and Terman (35); Challman (40); Hagman (87); Sulenger (204); Terman (208); Wellman (233).]

EDUCATION

Girls excel boys in school marks all the way through school and into the college levels. Even when matched for intelligence they have been known to receive higher grades; still more noteworthy they sometimes receive higher marks in those subjects in which achievement tests scores are higher for boys. In age-grade placement they are more advanced and they show less retardation in proportion to scores on a battery of achievement tests. Girls tend to graduate from eighth grade and high school at an earlier age. As has already been mentioned, more boys than girls are referred to clinics as deficient or backward. No difference has been found between the sexes in relation of school progress to health.

An explanation of the greater retardation of boys advanced by Cornell is that it is partly due to the slight advantage that girls have over boys of the same level of mental ability in expressing themselves linguistically, in orienting themselves to their surroundings, and in learning to read. The superiority of boys over girls of the same general mental level in ability to manipulate concrete things in a problem-solving way seems to Cornell to be an advantage that hinders rather than facilitates their school progress, because it denotes an interest apart from the usual school curriculum. A further disadvantage listed for boys is their greater instability, although the author was uncertain as to whether this is the cause or the effect of their retardation. Still another characteristic of boys (according to Cornell) is their tendency toward greater positiveness of personality traits. These differences are not large. "Probably no one of these differences in itself would be of much significance, but a combination of small divergences may have a rather large effect" (46, p. 226).

Two difficulties present themselves in the acceptance of this explanation in its entirety. The first is that it is questionable whether boys are emotionally more unstable than girls. (In Cornell's study this was determined by the ratings of teachers who gave the grades.) The second difficulty lies in reconciling this explanation with the findings of other investigations that boys can do better on standardized achievement tests and still receive lower grades.

Gifted girls in the California investigation received higher grades than boys. Teachers reported more girls than boys who showed "very extraordinary ability" in some special subject (42 per cent of the girls versus 28 per cent of the boys) and no difference in those who were "especially weak" (16 per cent of the girls versus 14 per cent of the boys).

[Burks, Jensen, and Terman (35); Cornell (46); Dayton (54); Elizabeth McCormick Memorial Fund (62); Emerson (63); Frasier (67); Gerberich (74, 75); Hollingworth (106); Lentz (124); Lincoln (129); Lund (133); Lurton (134); Phillips (175); Schmitt (189); Wallin (225, 227).]

In certain specific subject-matter the difference between the sexes is greater than in others. Girls excel in language, English, art, spelling, and handwriting. One investigator studying a thousand junior-high-school pupils found that approximately 10 per cent more intelligence was required of boys to achieve the same level of excellence in Spanish. The content in which boys take the lead is general science, chemistry, history, possibly general information, and possibly mathematics in the later ages (including geometry, although no differences have been found for algebra, and girls are sometimes found superior in arithmetic).

[Atkinson (8); Bassett (16, 17); Burks, Jensen, and Terman (35); Commins (44); Courtis (47); Emerson (63); Gesell (77); Hall (88, 89); Hanske (91); Kaulfers (116); Lund (133); Norris (162); O'Farrell (163); Pease (172); Perry (173); Probst (182); Pyle (184); Sackett (188); Sears (190); Smith (194); Starch (199); Stockard and Bell (201); Terman (208); Thorndike, Cobb, Orleans, Symonds, Wald, and Woodyard (211); Touton (212); Webb (231).]

It has been suggested that girls may lose more through lapse of time. A study of university freshmen scores on the Carnegie Foundation tests compared with the four years of high-school grades found the girls making a "poorer showing" in relation to their earlier standing.

> "Since the difference between the boys and the girls in scholastic and retest records seems too great to be due to different standards in marking boys and girls, we believe that at least a partial explanation may be found in differences in type of school mastery and differerences in interest and motivation. It is possible that the mastery of the girls is more verbal or rote and less logical than that of the boys. . . . . Interests and outlook of the girls being different, they are less motivated in the direction of logical mastery in many school subjects. Moreover, linguistic mastery of subject-matter is frequently all that is necessary in order to secure good grades" (133, p. 330).

Perhaps the discrepancy between high-school record and standardized tests at the college level might not have been so great had achievement tests rather than school grades been used in high school, and had a different selection of achievement tests been used as the criterion of achievement at the college level. The discrepancy between high-school record and college achievement was greatest in mathematics and the sciences and least in English. From the table presented it appears that when the sexes were matched on grades, the boys' superiority on the Carnegie tests and on the Iowa Mathematics Placement Test was greater than their superiority in intelligence as measured by the American Council on Education Intelligence Test. Their superiority was little affected by removing the English portions of the Carnegie tests. On the other hand, girls when matched with boys on grades were superior on the Bucknell English Placement Test, the language tests of the Columbia Research Bureau, and somewhat less so on the Carnegie English tests. The problem merits further consideration, especially in the light of the contention of Burks, Jensen,

and Terman that "gifted" boys maintain their level of intellectual superiority to a greater extent than "gifted" girls.

[Burks, Jensen, and Terman (35); Lund (133).]

Reviews and Summaries on Sex Differences

From time to time reviews on sex differences and the relative variability of the sexes in mental traits have appeared in the psychological periodicals. A few books dealing exclusively with this subject have also been published. Attention is here called particularly to the summaries prepared by Allen (2, 3); Burnham (36); Goodenough (81); Hollingworth (103, 104); Lehman and Witty (121); Lincoln (129); Louttit (131); Thompson (209); and Woolley (245, 246).

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CHAPTER 16

SPEECH PATHOLOGY[1]

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A CONSIDERATION OF THE NORMAL SPEECH ACT

Of all movements, those of speech expression present the greatest variety and complexity and comprise the largest number of diverse elements. In speech we find the most striking example of the highest type of integration of the entire organism. Here we find a single function, depending upon dissimilar structures each of which ordinarily subserves other and different functions, operating as a beautifully unified whole. The entire peripheral speech mechanism (lips, tongue, teeth, larynx, diaphragm, etc.) may be identified with biologically older and more fundamental vital functions which are seriously altered during speech. One is led to assume that this newer function of speech, in demanding exceedingly fine adjustments from the peripheral speech mechanism, places considerable strain upon it, the constituent parts of which were developed in relation to much simpler movements and coarser fundamental adjustments. There is not a single muscle group which has been developed to serve speech exclusively. The movements involved in the earlier established functions are generalized, and, although readily amenable to voluntary control, they are carried on largely unconsciously. By a process of high integration the neuromuscular basis of these generalized movements is utilized for the intricately coordinated movements of speech. In order to control efficiently the movements of parts common to many functions, the highest levels of integration necessarily alter some (e.g., breathing) and inhibit others (e.g., swallowing) of these functions. Although the same structures which subserve older and more established functions are coordinated to subserve the more recent and less well-established function of speech, the latter less-established function under normal speaking conditions dominates its dependencies. However, under certain unusual conditions speech-function dominance may be unseated in favor of some other-function dominance, such as that of swallowing or sucking. In so-called normal speaking the entire peripheral speech mechanism functions as a unit, several individual functions having coalesced to form the whole. In certain forms of abnormal speaking there occurs a dysintegration among the movements which is reflected not only in the individual part's but also in the whole of the mechanism.

[1]This chapter is based to a large extent upon the author's work, *Speech Pathology* (59). Particularly for records of the symptoms of stuttering, the reader should consult the figures in that work.

Structurally it is difficult to envisage the peripheral speech mechanism as a single organ, but functionally it is practical to do so. In so viewing it we must realize that innervations from the various parts of the central nervous system must be highly integrated. This leads us to think that a part of the nervous system exerts a dynastic influence (dominance) over other parts to insure concerted but unequivocal action. When such influence is disturbed because of diseases, injuries, emotional shocks, emotional maladjustments, and faulty training, the pathophysiological subsoil of the essential speech dysfunctions obtains.

Both clinical and experimental evidence points toward the existence of a field of chief dominance in the central nervous system for speech and other related activities such as reading and writing. In right-handed individuals it appears to be in the left cerebral hemisphere and in left-handed individuals in the right cerebral hemisphere. When we consider the great variety and complexity of movements resulting in speech, this power invested in the cerebrum assumes extreme significance. It is through just such superimposed and coordinating power that the movements of the individual parts of the speech mechanism are synthesized into the configuration known as normal speech. If it were not for this hierarchic control, the more fundamental natures of the subordinated powers could assert themselves to the consequent disconformity to and disconcertion of the speech act.

Speech is composed of a succession of synergic movements and alternating changes in various muscle groups each of which also performs in other more elemental acts. The complete speech act in its perfect form demands the mobilization in proper sequence of a series of complex procedures wherein the time relation is of fundamental importance. A lack of chronological exactitude will throw the whole performance into disorder. Too, there is the widest combination of stimuli, differing in origin, feeling, aim, and significance to function in speech. It is well to conceive of speech as a dominant kinetic rhythm which may be interrupted by a wide variety of factors. An interruption would result in inconstancies in the progress of the forward-flowing process peculiar to vocal expression. When one envisages this activity as consisting of an orderly march of a highly integrated series of voluntary and automatic processes requiring perfect action of both cortical and subcortical mechanisms, it is not surprising that a relatively small percentage of individuals have disorders of speech. Rather it is surprising that so many have normal speech.

Classification of Speech Disorders

Definition of a Speech Defect. Man differs markedly from all other living creatures in having three forms of social control known as speaking, reading, and writing. Of these three tools speech stands apart as the master instrument with which man controls his social environment. Socially, speech is at once the most important source of stimulation for, and the most significant response of, the human organism. When an

individual speaks, he always reveals something, sometimes it is himself. It may not be what he intended to disclose, but nevertheless it is telltale in some manner.

It is obvious that no two individuals possess the same speech patterns; each person possesses an accent of individuality. Yet the speech function is highly standardized and socially valuable in direct proportion to its standardization. We have learned to respond in a certain way to a certain speech pattern and to produce such and such a speech pattern to elicit such and such a response. If speech as a stimulus pattern is varied in some of its attributes (quality, intensity, duration, pitch, silent intervals) or in the way the latter are combined so that it is unusual and represents a conspicuously wide deviation from the usual or normal, the response may be halting or entirely fail to appear. In a sense such a stimulus pattern is inadequate because it is a peculiar one to which other individuals have not learned specifically to respond. Inadequate adjustments follow, not only on the part of the auditor, but also on the part of the speaker. Exactly this situation exists in the case of the speech or voice defective. Hence we may define a speech or voice defect as an unusually conspicuous deviation in the speech pattern of an individual which is incapable of bringing about an adequate social response and which by the same token constitutes a maladjustment to his environment.

Classification of Speech Disorders. At the present time any attempt at grouping speech disorders under sharply distinct heads must be but tentative and imperfect. Classifications should change with changing concepts and new discoveries. Until we know the exact nature of every disturbance of speech there will remain a great difference in viewpoints. I have found it profitable to group speech disorders under the three following heads:[2]

1. Disorders of rhythm in verbal expression
2. Disorders of articulation and vocalization
3. Disorders of symbolic formulation and expression

Disorders of Rhythm in Verbal Expression

These disorders of speech include those commonly known as stuttering and stammering. Basically, stuttering and stammering are the same. Practically, stuttering is characterized by the repetition of sounds, words, or phrases while stammering is characterized by speech blocks. The apparent repeating of the same sound or word represents frequently transient speech blocks. The repetition consists of alternate blocks and releases. It is clonic activity. In this sense there is no fundamental difference between repeating (clonic activity) and blocking (tonic activity), the latter being merely a marked prolongation of the block phase of the former. Generally speaking, every stutterer presents both types of difficulty.

[2]The sudent wishing a more elaborate and detailed classification of speech disorders will find one published in S. D. Robbins and S. M. Stinchfield, *A Dictionary of Terms Dealing with Disorders of Speech* (51).

Some General Facts about Stuttering

a. The incidence of stuttering. There is a fairly close agreement among surveys that approximately 1.0 per cent of the school population are stutterers. Boys outnumber girls in a ratio of from 2 to 1, to 10 to 1. The ratio changes with age; the greater the age the greater the preponderance of male over female stutterers. Boys are not only more apt to stutter, but are much more likely to persist in the defect. No adequate explanations have ever been advanced to account for these sex differences.

b. Stuttering and mental defect. Special classes contain more stutterers than do the regular classes. Other things being equal, the mentally defective child, because of his immaturity, is more apt to stutter than is the normal child. However, we must not stress too much this apparent relationship between defective intelligence and stuttering. Travis (59) reported the mental ratings on 73 public-school stutterers. The distribution of IQ's was practically normal, with a range of from 60 to 139. Thirty-seven per cent of the children gave IQ's between 100 and 109, 27 per cent between 110 and 139, and 36 per cent between 60 and 99. It must be observed that intelligence tests, especially those which involve speaking, tend to depreciate the stutterer's ability. It is reasonable to suppose that in so far as intelligence involves adaptability, and in so far as adaptability involves normal speech, stuttering is certainly a deterrent in the stutterer's attempts to exhibit his native intelligence. The stutterers in the University of Iowa have been superior to the average college student in intelligence. The selective factor at work operates more completely in the case of the stutterer who hesitates to go to collge with two handicaps, stuttering and mental dullness.

c. Age of onset of stuttering. Approximately 85 per cent of stutterers begin to stutter before eight years of age. A relatively large number of children stutter with the beginning of speech. This reveals that stuttering is a developmental disorder in childhood. More frequently than not stuttering appears gradually rather than suddenly, especially in children. Often it is preceded by hesitancy and uncertainty in speaking or a tendency to repeat sounds or words. When these characteristics become crystallized and accentuated into clonic and tonic spasms we have the full-blown symptoms of a real stutter.

d. Outgrowing of stuttering. Although we have no reliable information on this point, workers in speech correction are of the opinion that as high as 15 or 20 per cent of children stutter some time or other during their lives usually between two and four years of age. If this is true, then the majority of children outgrow or overcome their stuttering, inasmuch as only 1 per cent of school children have the affliction. From this may have arisen the popular notion that the stutterer is likely to outgrow his defect even if no special effort is made to remedy it. However, a study of children with diagnosed stuttering reveals the danger of such an attitude. Wallin (70) reported that the number of stutterers rose with advancing grade. In the first grade approximately .7 per cent and in the

eighth grade approximately 1 per cent of the children stuttered. Over a period of eight years about 1 per cent of the freshmen at the University of Iowa have been stutterers. Thus we see that if any significant number of stutterers outgrow stuttering they must do it before entering the first grade in school.

e. Stuttering and scholastic achievement. In general, the stuttering child is retarded about a year and a half in school. The retardation seems greater in the earlier grades, which indicates again that the stutterer presents largely a problem in maturation. Among others, there are three reasons for this retardation: First, the child is unable to express himself well in oral recitation. He may pretend ignorance or give an answer which is entirely different from what he really intended to give. Secondly, stuttering is frequently associated with deficiencies in other modes of expression such as writing and in reading (both oral and silent). And, thirdly, the emotional maladjustments accompanying the disorder militate against the power of concentration and application in study.

f. The number of stutterers as compared with that of other disabilities. There are over one million stutterers in the United States. Of this number approximately a quarter of a million are children. Government bulletins (1920) report that there are 52,567 blind persons and 44,885 deaf-mutes in the United States. Thus there are nearly three times as many stuttering children as the blind and the deaf-mutes combined.

Symptomatology of Stuttering (19, 56, 57, 21, 7). The symptoms of stuttering represent various inconstancies in the progress of the forward-moving process of speech. In one sense stuttering may be thought of as a disturbance of rhythm in verbal expression. In stuttering there is a marked dysintegration in the various movements of the speech apparatus. Various parts function out of temporal and directional phases with other parts.

In normal speech there are fairly fixed relations between movements of parts of the speech apparatus (56). First, there is a synchronism between thoracic and abdominal movements during speech. Generally it may be said that the thorax and abdomen act as a unit. Secondly, there is a greater number of vertical laryngeal movements than expiratory movements, actual count revealing that the larynx makes an average of six complete up-and-down movements during one expiration. This organ is raised and lowered under several conditions during speech. However, the majority of the vertical movements of the larynx are secondary to movements of the tongue and soft palate and are therefore to be considered predominantly articulatory in character. Generally they and the breathing movements appear to be independent of each other. This does not mean, however, that these two sets of movements are not closely related in a high degree of integration. Both of them are controlled undoubtedly by a coordinating mechanism to function together adequately in speech. Thirdly, there is a rhythm in breathing, in the vertical movements of the larynx, and in the changes in breath pressure. These various movements and changes

are not perfectly regular by any means, but neither long intervals without movements nor periods of excessively fast movements occur. Fourthly, there is a marked increase in the relative length of expiration during speech. As far as speech is concerned, inspiration serves only to supply air as quickly and with as little trouble as possible to be used during expiration for vocalization and articulation. In other words, we speak on expiration. Consequently, it is proportionately greatly increased to suit the thought phrases in utterance. Fifthly, consecutive inspiratory and expiratory movements are of about equal extent. It appears that the normal speaker uses an optimal amount of his air supply for each speech phrase with the result that he does not force all of the air out of the lungs in an intense expiration or inspire again when he already possesses an adequate supply of air to finish the phrase.

These relations existing between the movements of the various parts of the speech mechanism indicate that the motor speech units are well integrated to assure the provision of an even, adequate, periodically renewed supply of air for the voice-producing and articulatory mechanisms as well as for the whole organism. A lack of such integration is the main manifestation of stuttering. It reveals itself in many ways some of which are discussed below.

a. Diametrical opposition of the action of the thorax and of the abdomen. During stuttering, breathing records often indicate abdominal inspiration and thoracic expiration at one time and abdominal expiration and thoracic inspiration at another time. The two movements, inspiratory and expiratory, carried on simultaneously by the two parts, thorax and abdomen, may appear to be of about equal strength and thus tend to neutralize each other. Hence, during the period when the antagonistic action is the most pronounced, the air column will not move, making vocalization and articulation impossible. At other times when the two opposite movements are not of equal extent, the air column may move and vocalization or articulation or both may take place. However, under such a condition speech is generally abnormal.

b. Synchronism of movements of the larynx and those of the abdomen and thorax. There are several varieties of synchronous functioning of the larynx, abdomen, and thorax. One is revealed when the larynx and the abdomen are displaying a marked similarity of movement while the chest is moving out of time with them. When the abdomen is extended, the larynx is elevated, and when the abdomen is distended the larynx is depressed. The movements of the chest appear to bear no relationship whatever to those of the other two units. In some instances in which the synchronism between abdominal and laryngeal movements lasts for several expirations the thorax fails to indicate a single complete expiratory movement. Another type of synchronous functioning of the breathing units and larynx is seen when the abdomen, thorax, and larynx make brief, simultaneous movements at the rate of approximately 1.5 a second. In some instances the larynx is elevated for inspiration and depressed for

expiration, while in others it is depressed for inspiration and elevated for expiration. Thus it appears that during stuttering, instead of showing the independent and faster rate of rise and fall which characterizes normal speech, the larynx may move synchronously with the abdomen or the thorax or both.

c. Marked protraction of inspiration. Inspiration may continue as long as 10 seconds while the stutterer is attempting to speak. During some of the periods of abnormally long inspiration the larynx may be in a tonic spasm, or suffer several large vertical movements, in most instances approximating a rate of about one movement a second. During other such periods the breathing units as well as the larynx are giving rather regular, rhythmical clonic movements of a rate of approximately three per second. Such inspiration periods are frequently terminated by a rather sudden and brief respiratory movement.

d. Marked protraction of expiration. Although it is normal to have the expiratory period considerably lengthened during speech it is certainly abnormal to have it lengthened to such degrees as it sometimes is during certain stuttering periods. During normal speech the expiratory period is about five times as long as the inspiratory period. During stuttering the former may become fifteen times as long as the latter.

e. Marked inequality in the extent of consecutive respiratory movements. It is true that there is variation in the extent of consecutive respiratory (both inspiratory and expiratory) movements during normal utterance. However, the variability assumes pathologic degrees during stuttering. In certain instances a deep inspiration at the beginning of respiration contrasts sharply with following short inspiratory interruptions of expiration. In other instances an inspiration of average extent contrasts sharply with the following expiration of great or small extent. Then, too, an expiration may contrast strikingly in extent with its follower.

f. Interruptions of expiratory by short inspiratory movements. This is a very common finding in the breathing curves of stutterers. A long respiratory interval may become so broken up by inspiratory interruptions that it is scarcely recognizable. The whole performance resembles slow panting.

g. Clonic and tonic spasms. Spasms in the musculature of the speech mechanism may be of short or exceedingly long duration and of the clonic or tonic kind. A tonic spasm of the muscles of respiration may last as long as 20 seconds. In clonic spasms, the clonic movements may be as fast as 10 movements per second. Spasms are not confined to the breathing musculature alone but appear in muscles of the larynx and in the controlling organs of articulation. The entire speech mechanism or one or more of its parts may be affected at one time.

h. Tremors in certain movements of the speech mechanism. During stuttering some cases show a fine tremor of the abdominal musculature, lips, and jaw with a rate of 10 to 12 tremors per second. Oc-

casionally these tremors appear in muscles not directly related to speech, such as the pectoralis major muscles. In my experience periodic fluctuations in pitch of a rate of from 4 to 9 pulsations per second (vibrato) occur in a certain number of the stutterer's tones during unemotional, conversational speech. In the case of the normal speaker they do not occur in any tones of similar speech. This vibrato is probably the result of clonic contractions in some or all of the muscles responsible for voice production.

i. Tonal rigidity in the voice. The variation in pitch which is characteristic of the normal tone indicates that in the normal speaker there occur alterations of the fixed muscular tension which would be requisite for the maintenance of a tone of absolutely constant pitch. The normal speaker presents a flexibility in muscular control. The absence of pitch variations especially for any appreciable length of time is to be considered as abnormal. The abnormality would seem to consist of a marked fixation on the part of those muscles which have to do with altering the tension of the vocal cords, so that the muscular balance necessary for tone production is maintained in a condition of rigidity which is pathologic. Tones of relatively long duration with no determinable variation in pitch are frequently encountered in the stutterer's voice records.

j. Abnormally long duration in tones. In general, the stutterer holds his tones almost three times as long as does the normal speaker. He shows also greater variation than does the normal speaker in the length of time he holds them. It should not be surprising to find these marked differences between stutterers and non-stutterers in duration of speech sounds. The same factors that are responsible for the stutterer's inability to begin a sound would seem to express themselves in the initiation of the subsequent sound.

k. Periodic fluctuation of breath pressure. A periodic fluctuation in breath pressure is evident in many photographic records of the stutterer's speech just before and immediately after tones. These waves occur at a rate varying from 25 to 50 per second both during stuttering and when there are no observable signs of difficulty in speaking. However, they rarely if ever occur in the free speech of the normal speaker.

l. Pathologic variations in the form, extent, and length of consecutive voice waves. Although there are wave-to-wave fluctuations in the voice records of normal speakers they are relatively gradual and smooth. In the stutterer recorded variations in the form, extent, and length of consecutive voice waves are so striking as to be considered characteristic of the abnormality.

m. Extremely brief approximation of the vocal bands before and between tones. In the speech records of many stutterers there occur two double vibrations before the voice waves proper begin. The length of time elapsing between these double vibrations and the voice waves varies in different cases and for the same individual at different times. It rarely, if ever, exceeds 0.04 second. In some records the voice waves will be

preceded by one double vibration. This shows that the vocal bands may be brought close to each other to vibrate and then separated sufficiently so as not to vibrate within the time of 1/200 of a second.

n. Periodic approximations of the vocal bands between tones. Voice records of certain severe cases of stuttering show groups of low-amplitude, high-frequency oscillations occurring periodically at a rate of approximately 16 per second between and after tones in unemotional, propositional speech. These groups have never been observed to precede the voice waves of the first tone of a sentence. They appear, therefore, to be related to cessation rather than to initiation of voice. The rate of the oscillations within the groups varies from 500 to 900 per second. Although this phenomenon is best seen on an out-going breath stream of medium intensity, it is present even when the passage of air is relatively rapid during both inspiration and expiration. Similar groups of small oscillations may be observed to occur during vocalization.

o. Extreme abruptness of initiation of tones. In the normal speech tone there is a more or less gradual building-up in the amplitude of the waves until the maximum is reached in from 3 to 10 waves. In the stutterer's speech records there occur frequently, without previous vocalization, extremely suddenly initiated tones in which the first wave is as large if not larger than any of its followers. Such records thus show two peculiarities when compared with those of normal speech tones: first, the extreme suddenness with which the vibrations begin, and, secondly, the extensive relative amplitude of the first wave.

p. Repetition of sounds, words, and phrases. Repetition of speech units is one of the most obvious signs of stuttering. The repeating of the same sound or word represents frequently transient speech blocks. We may think of this repetition as consisting of alternate blocks and releases. It is clonic activity.

q. Speech blocks. A stutterer presents a speech block when in attempting to speak he is unable for an appreciable length of time to produce a sound. This is tonic activity. Blocks and repetitions are not single symptomatological entities but are complex abnormalities of functioning of the entire speech apparatus. They may involve any or all such factors as tonic or clonic spasms in some or in all of the speech muscles, anachronisms amounting to complete opposition between the movements of the chest and those of the abdomen in breathing, and some type of synchronous functioning of the larynx and breathing apparatus.

r. Dysintegration in the movements of the speech mechanism as a whole. In normal speech the entire speech mechanism functions as a unit. In stuttering, the various so-called parts of this mechanism function independently of each other to produce the symptoms we have been discussing. Any given individual unit of the speech mechanism may be functioning relatively normally but not in harmony with its fellow units. Chronological exactitude in the movements of one part in relation to the

movements of all other parts is one of the most important single elements in speech production. If it is lacking, normal speech is impossible.

Etiology of Stuttering. Realizing the human organism's multidimensional make-up it is well to conceive determinants effecting its expression in a very broad way. The acceptable viewpoint of etiology in any given disorder of speech comprehends the disorder as a resultant of causes. I have tried to note major causes of stuttering because of their particular importance for clinical and research interests. In doing this certain factors which may seem to be important to some workers are relegated to a subordinate position as precipitating factors or accessory causes.

a. Heredity. It is probably safe to say that heredity may play a rôle in the development of pathophysiological mechanisms similar to that which it plays in the production of physiological ones. If this be true, or only partially so, the influence of heredity in the production of stuttering is a powerful one. However, all persons who are in this basic respect capable of stuttering need not stutter. Whether or not they shall stutter will depend upon further injuriously shaping, formative, and precipitating influences. I do not presume to evaluate in its entirety the rôle of heredity. However, its application can be seen in the following statements.

Makuen (36) reported from a study of 1000 stutterers that 39 per cent have or have had relatives who stutter. He concluded that heredity must be held responsible for the cortical speech mechanism which sooner or later gives rise to stuttering.

From a study of 594 stutterers for whom reliable information could be gathered Professor Bryngelson of the University of Minnesota reports that 74.6 per cent have or have had relatives who stutter. When he divided the large group into two groups according to sex, 71 per cent of 394 male stutterers and 81 per cent of 200 female stutterers have or have had relatives who stutter. When only those stutterers who were 16 years of age or older were considered, 71 per cent of 133 male stutterers and 91 per cent of 77 female stutterers have or have had stuttering relatives. Of 160 stutterers, largely university adults, who have been examined at the University of Iowa during the last few years, 68 per cent reported stuttering in the hereditary background. Of the 127 male stutterers, 64 per cent, and of the 33 female stutterers, 82 per cent reported stuttering in the hereditary background. Bryngelson reports that of 225 normal speakers (all ages) 11 per cent had stuttering in the family. Of 578 University of Iowa freshmen, including stutterers, 9 per cent reported stuttering in the family stock. Inasmuch as the methods for obtaining these figures at Minnesota and Iowa were practically identical for both the stutterers and the normal speakers, we may safely assume that a significantly greater number of stutterers than normal speakers have or have had stuttering relatives.

b. Brain injuries at, and subsequent to, birth. The great number of abnormal conditions which enter into the production of stuttering necessitates the consideration not only of the organism but also of the

organism's experiences. Every worker in the field is impressed by the fact that, of a number of children who have been subjected to the same disease, accident, or unfortunate educational influences relating to speech, only a relatively few develop stuttering. This fact appears to support the assumption that such abnormal conditions are commonly able to produce the disorder only when acting upon a constitution peculiarly, but, by the very composite nature of the act, probably not specifically, capable of such. Approaching the study of the effect of brain injuries in this light, we see them operating usually as contributory factors lacking directional specificity. It is conceivable, however, that a brain injury might so disturb the functional integration of the central nervous system as to operate as a primary cause of stuttering.

Ehrenfest (16) reported that certain observers have found intraocular hemorrhage in as high as 34 per cent of infants examined within 24 hours following birth. These hemorrhages are due to excessive pressure exerted on the head of the child during birth and they stand in some relation to minute and larger cerebral hemorrhages. These findings indicate that, as a result of the disproportion between the woman's pelvis and the child's head, the event of birth afflicts relatively large numbers with an injury to the brain. Of the stutterers I have studied, certain ones have suffered from birth injuries resulting in definite neurological disturbances which were considered to be directly related to the stuttering.

Gerstmann and Schilder (22) have reported cases of post-encephalitis with pronounced speech disturbances which could not be distinguished from stuttering. These disturbances consisted of an initial block and tonic and clonic hypertonicity. They appeared four months after acute encephalitis. These same authors reported a form of stuttering in motor disturbances of the pseudobulbar type which appear only in connection with extrapyramidal disease, which do not show any supranuclear lesions, and which give a picture different from genuine pseudobulbar paralysis. There is an initial block in speaking. Before he can speak, the patient seems obliged to overcome an obstacle. The resulting process can scarcely be distinguished from clonic and tonic stuttering.

One of my stutterers was a patient with a determined diagnosis of cerebral arteriosclerosis. He presented an extremely rapid repetition (8 repetitions per second) of the first sound of a word with usually no trouble on the remaining sounds. Another case is informative. Before she had infantile spastic paralysis she was a normal, well-developed child. After her illness in preschool years she did not talk for a year. Upon the resumption of speech she presented a bad stutter. At the present time, at the age of thirteen years, she stutters severely and presents an atrophy and paralysis of the right hand and forearm.

c. Physical and mental diseases: The importance of physical and mental diseases in the production of stuttering is universally recognized. From a study of his 1000 cases, Makuen (36) concluded that infectious diseases such as whooping cough, measles, diphtheria, and smallpox, are

important etiological factors. Bryngelson reports that, for his 700 cases of stuttering, convulsions, meningitis, severe whooping cough, diphtheria, and pneumonia in the preschool years bear a close relation to the onset of stuttering. Of the cases that have passed through the University of Iowa Speech Clinic during the past few years, 30 per cent have given histories of having had febrile diseases with deliria, transient nervous disorders such as St. Vitus' dance, and neuromuscular instabilities of undetermined origin and nature prior to the onset of stuttering. In their selective action on the highest levels of nervous integration, physical diseases disrupt normal speech development and production. For the same reason and in the same way mental diseases affect speech. One of my cases that had stuttered since childhood was psychiatrically a case of cyclothymia. Following a few months of being very active, alert, and steadily on the move (playing the piano, singing, talking), she would enter upon a period in which she was noticeably quiet and inactive. During the quiet periods, speaking only when addressed, she stuttered badly. During her buoyant periods she talked volubly and comparatively fluently, stuttering only occasionally. Conceivably, during the latter periods the inordinate activity of the higher nervous centers was accompanied by their increased powers of integration (14).

d. Emotional factors. Prolonged emotional excitement and emotional shocks, in their relatively greater deleterious influence upon the higher, more susceptible dominant centers, selectively but commonly damage the central plan of organized vocal expression. In one of my cases his stuttering dated from a severe emotional shock experienced at nine years of age. The stuttering appeared suddenly following the emotional experience. In another case the stuttering appeared gradually following a long period of excessive psychic tension in the family circle. Allied concerns, such as fear, excessive timidity, hypersensitivity, feelings of inferiority, self-consciousness, and anxiety, may be considered both respectively and circularly as cause-and-effect factors in stuttering.

These examples, while they do not treat the subject of etiology exhaustively, may serve to indicate how stuttering is a resultant of causes. They may indicate, also, that each stutterer must be considered an individual case.

Nature of Stuttering

a. Various viewpoints of stuttering. The writings of specialists in the field of speech pathology reveal a number of different viewpoints with regard to the nature of stuttering. As I see it, these viewpoints may be grouped under five large heads: educational, psychological, mental hygiene, psychoanalytical, and neurological. These overlap at practically every turn, but a shift of emphasis in the one distinguishes it from all the others.

McDowell (74) and Russell (74) are representative of those who hold primarily to the educational concept of stuttering. According to these writers, stuttering is a bad habit. Treatment consists of substituting

satisfactory speech reactions for the stuttering by applying the laws of learning which operate in the acquisition of every reaction.

The psychological concept of stuttering is held by such workers as Bluemel (5) and Swift (54). The former believes that a speech or thought block arises when verbal imagery or mental speech recoils from the stream of consciousness. The latter thinks that at the time of stuttering the stutterer has a temporary or permanent lack of a visual process which controls speech. Treatment emphasizes attending to mental speech, listening for the words and speaking them by merely thinking aloud, and by "visual building."

The mental-hygiene point of view holds that stuttering is a personality disorder characterized by the stutterer's tendency to react inadequately, through speech, to certain or all social situations. The speech disturbance is the most noticeable symptom of deeper emotional conflicts. Most prominent in the development of this viewpoint have been Blanton (3) and Fletcher (20). In treatment the emphasis is on emotional adjustment within the individual and the altering of his environment where certain factors such as the attitudes and habits of parents, teachers, and others tend to make reasonable adjustments on his part difficult or impossible of attainment.

The psychoanalytical viewpoint holds that stuttering is a psychoneurosis in which there is a stubborn, sterile type of repetition of oral material that indicates oral eroticism. The stutterer does not want to "spit out" the words. He has regressed from his anal to the oral level and given the mouth a sphincter innervation which seems to indicate that he wishes to retain the words as objects, using the mouth as a sphincter. Coriat (10) is the chief exponent of this interpretation of stuttering. The treatment is by thorough psychoanalysis which concentrates on the oral libido and its consequent character traits and not on the neurotic anxiety or fear.

The neurological envisagement of stuttering has been put forth mainly by Sachs (52), Orton (42, 43), and Travis (59). Blanton (4) developed a theory of stuttering in which the neurological aspects were emphasized. Sachs states that some forms of stuttering at least seem to indicate that the impulses which are equal in both hemispheres, instead of fusing with each other harmoniously, follow each other separated by a short interval of time, as it were, and, interfering with each other, show their bilateral origin. Orton believes that in man's brain the entire initiatory control of certain major functions, such as speech, writing, and reading, is in one cerebral hemisphere. Dominance or some form of initiatory control would seem necessary to prevent confusion of responses such as would result if either hemisphere were competent to lead without reference to the activities of the other. Travis feels that during normal speech the two cerebral hemispheres function concordantly and harmoniously to control the two sides of the speech mechanism as a unit and that during stuttering they function indepen-

dently and disharmoniously to produce disconcertion of the speech act. The harmonious functioning of the two hemispheres is due to a hierarchic relationship between them. If for various reasons such a relationship does not exist, then the high degree of integration of the entire central nervous system necessary for the adequate control of the complex speech mechanism is impossible. Blanton holds that stuttering may be due to a lack of discriminative and inhibitory function of the cerebral cortex over lower nerve centers, particularly the thalamus, with the result that the various muscle groups involved in speaking lose their coordinated relationship and each group acts under the influence of its own lower nerve centers. All of these workers agree on one point, namely, that during stuttering there is a disturbance in the integrative powers of the highest neurological levels (cerebral hemispheres). Sachs, Orton, and Travis see this as due to a lack of dominance in the one or the other of the two cerebral hemispheres, while Blanton feels that it is because of the relative hyperactivity of the lower neurological levels, particularly the thalamus, which is so important in emotional life. Travis envisages many of the symptoms of stuttering as evidences of lower neurological levels' control over the speech muscles. This, in turn, is due to the reduced cortical-lead control because of transient and mutually inhibitive activities of the right and the left cerebral hemispheres.

b. Experimental evidence supporting the neurological concepts of stuttering. There is some experimental evidence for these neurological concepts of the nature of stuttering. I shall list briefly the results of four researches.

It may be observed that the fingers when extended present small rhythmical movements or tremors which may be shown to occur at a general rate of 8 to 12 tremors per second. Travis (60) has found that in patients with the cortical motor pathways interrupted and the lower levels intact the tremors were not present. Further, he found that the tremors bear a definite relation to voluntary movements. These findings would indicate that cortical activity is necessary for the appearance of the tremors. Starting from this point, Herren (28) determined that stuttering depressed the tremors of a rate of 8 to 12 per second and that voluntary movement of the finger produced a greater percentage of tremors of a rate of 40 to 75 per second in stutterers than in normal speakers. To aid in the interpretations of these findings Herren studied the effects of a depressing drug (alcohol) upon the tremors. He found that alcohol depressed the tremors of a rate of 8 to 12 per second and caused the appearance of two other tremor rates, one of 15 to 20 tremors per second and the other of 40 to 75 tremors per second. On the basis of Travis' findings and those of Herren on alcohol, one would conclude that stuttering was coexistent with a reduction in cortical activity. Further evidence of this was found by Travis (59) who reported that during a tonic block the patellar-tendon reflex response latency was significantly reduced in the majority of stutterers. According to previous

studies by Travis and Dorsey (63, 64, 13), when the activity was decreased in the highest levels in the central nervous system, the patellar-tendon reflex response latency was decreased; when the activity in the highest levels was increased the reflex response latency was increased. That is, the greater and lesser irradiation of the highest levels of the central nervous system respectively increased and decreased the reflex response latency. Thus a reduced reflex response latency during stuttering would indicate that a reduction in the cortical control and inhibition of lower nervous arcs existed during the stuttering act.

Another study supporting the general concept that the act of stuttering may be envisaged as a temporary recurrent reduction in the dynastic control of the superjacent levels over their substructures was reported by Jasper and Murray (30). Among other things, they found an automatic or reflex type of eye-movement during stuttering in oral reading that consisted of rapid movements and marked vertical twitches of the eyes. These stood in striking contrast to the eye-movements characteristic of normal speakers in oral reading.

The latest neurological study of stuttering was made by Travis (61). He recorded the nerve impulses from the two masseter muscles during stuttering and during the free speech of both the stutterer and the normal speaker. The theoretical importance of the problem lies in the fact that this pair of speech muscles, like all other pairs of speech muscles, is bilaterally innervated. In the free speech of both stutterers and normal speakers the two masseter muscles gave nerve impulses which were very similar in frequency, extent, wave form, and general patterning. During stuttering these muscles gave strikingly dissimilar nerve-impulse pictures. The nerve impulses from one side would be exceptionally large, while those from the other side would be scarcely discernible; those from one side would appear in volleys at a rate of from 10 to 40 volleys per second, while those from the other side would be absent, or greatly reduced in size, or continuous; the volleys from one side would appear out of time with respect to those from the other side; the nerve impulses from one side would be of much greater frequency than those from the other side; and those from one side would give a strikingly different pattern from that shown by the other side. These findings indicate that during normal speech the two cerebral hemispheres are functioning concordantly and harmoniously to control the two sides of the speech mechanism as a unit and that during stuttering they are functioning independently and disharmoniously to produce disconcertion of the speech act.

A certain insight into the way in which the multiple activities commonly ascribed to the cerebral hemispheres may become systematized in the control of structures common to both hemispheres may be gained from a study reported by Travis and Dorsey (65). During voluntary movements of the rat these authors recorded the nerve impulses from two varyingly separated brain areas. For the two motor fields (right and left) the synchronization and isomorphism of the nerve impulses were

striking. Similar kindred relationships between the nerve impulses from the two hemispheres were noted in the visual and common sensory fields. These relationships were most wanting in the two compared auditory fields. It is conceivable that, as the final common motor pathways out of the brain are approached, the right and the left motor impulses in some way, possibly by the former's accepting the latter's rhythm, coalesce to result in the perfect synarchy which is essential for unified control. It is thought-provoking to view this process as a dynamic act of unification on the parts of the two hemipsheres producing a oneness in their outputs. Such an idea may be significant for the problem of cerebral hemispheric dominance. Any significant variation in the oneness of the hemispheric outputs such as was revealed in the nerve impulses from the two masseter muscles during stuttering may account for the basic underlying disturbance in this disorder of speech.

c. The far-reaching effects of stuttering. Herren (27) has demonstrated that stuttering has a profound effect upon voluntary movements of parts of the body not directly concerned with speech production. Stuttering would often completely inhibit rhythmical voluntary movements of the fingers. During an entire speech block the fingers would remain perfectly quiet. The longest of such periods occurred during a prolonged tonic spasm of the entire speech musculature. During clonic seizures the finger movements would cease for the first seizure and appear during the first release, cease again for the second seizure and appear again during the second release, and so on. Generally, one or two contractions were absent at a time. Usually, when both hands were used, the absence of movement occurred in the two hands at the same time. Sometimes, however, one hand continued to carry on the rhythm even after the other hand ceased to move. At certain times there would be a gradual decrease in the extent of the movements which would correspond roughly to the length and severity of the speech block. At other times stuttering frequently caused the two hands to change from opening and closing in positive phase to opening and closing in negative phase (when the one hand closed, the other hand opened, and *vice versa*). The same results were found in a study of the movements of the toes. It appears from this study that stuttering consists of tonic and clonic blocks not only in the speech mechanism, but also in extra-speech structures such as the hands and feet. Thus stuttering is seen to be one sign of a generalized loss in the integration and control of voluntary movements of all parts of the body.

Still more evidence of the far-flung delimitations placed upon the individual by virtue of his being a stutterer is found in the studies of Blackburn (2) and West (73). The former author found that the stutterer is inferior to the normal speaker in the control of simple voluntary rhythmical movements of the diaphragm, tongue, lips, and lower jaw. The latter author found the same differences between the two types of individuals in regard to purely repetitive movements of the jaw and eyebrows.

In addition to the stutterer's not being able to compete on equal terms with the normal speaker in the manipulation of his speech apparatus in speech, these studies show that he is unable to compete on equal terms with the normal individual in the separate control of single parts of the speech apparatus.

Another study showing the ramifications of stuttering was made by Murray (39). He found in stutterers a good many of the same disturbances in breathing during silent reading and "thinking" as occur during speech. As with speech, the records indicated, among other things, abdominal inspiration and thoracic expiration at one time and abdominal expiration and thoracic inspiration at another time, and tonic and clonic spasms of the breathing muscles. Further, he found that during silent reading the stutterer commonly has more eye-movements per line of reading material than the normal speaker. Occasionally the stutterer begins to read from the right rather than from the left side of the page. His return eye-movements (from the right to the left side of the printed material) are much less accurate and precise. Instances of relatively long eye fixations appear frequently in the stutterer's reading. These may be thought of as analogous to tonic spasms in the speech muscles during stuttering.

All of these findings convince us that in certain activities other than speech the stutterer is fundamentally different from the normal speaker. We must cease to think of stuttering simply as a speech defect, but must consider it as a concurrent of other both simple and complex advertisements of a basic neurophysiological deviation.

Management of Stuttering. Every stutterer presents an individual problem. Although the general principles of management may be the same for a number of stutterers, the specific indications vary for one and another. For this reason each stutterer must be thoroughly studied from all angles in order that remedial measures specifically adapted to his needs may be instituted. As is every other human being, the stutterer is the resultant of two factors—heredity and environment. We wish to know, therefore, what he brought into the world with him in the way of native equipment and what has happened to that equipment since birth. This information is derived mainly from a case-history study of his family stock and of his own organism from conception to the present, from physical and psychological examinations, and from specially devised diagnostic tests. It cannot be too strongly emphasized that comprehensive evaluation of the stutterer from all possible angles is essential to the understanding of his case.

The general aim in the management of the stutterer is to give him excellent physical and mental health. The specific aim in his management is to overcome his stuttering and possible allied defects such as reading and writing disabilities. The methods for realizing the first aim are quite universally recognized. In regard to physical hygiene we may mention particularly the matter of diet and exercise. The general prob-

lem of malnutrition is so broad that we cannot possibly take adequate account of it here. It is important to the speech pathologist because nutrition is fundamental for all lines of child development. The stability of the total bodily structure is dependent in large part upon the materials that make it up. Ill-nourished children and adults are very susceptible to all types of infection. Proper exercise is just as important as proper diet. The stutterer should be placed under a regimen of wholesome spontaneous activity. Freedom and abandon in general bodily movements and vigorous body tone should be cultivated. Well-lighted and well-ventilated sleeping quarters are necessary for perfect health. Effects sometimes traceable to poor ventilation are lassitude, drowsiness, headache, faintness, dizziness, and "nervousness." Besides illustrating selective action upon the higher levels of integration such effects constitute sure signs of reduction of the efficiency of the organism as a whole. Ideally, the child's sleeping conditions should be arranged so that he sleeps alone. In the case of the nervous child we advise having him relax after luncheon and dinner. Other periods of the day may be set aside for rest and relaxation.

In general, the work in mental hygiene deals with the emotional life of the stutterer and his home and school life. Both of these refer to the adequate patterning of the emotional life of the individual.

Psychoanalysis may be of decided help as a medical treatment of stuttering. In a certain number of cases this form of therapy appears to be the indicated major remedy.

Psychologically, we may divide the stuttering process into three phases, the pre-spasm, the spasm, and the post-spasm phase.[3] The pre-spasm phase consists essentially of emotional and attitudinal reactions to, and changes in muscle tone preceding, the oncoming neuromuscular spasms. The spasm phase is the actual muscular incoordinations. The post-spasm phase begins at the instant the stutterer senses any incoordination in his speech muscles, and it is in essence his reaction to that muscular incoordination. Generally this reaction to the muscle spasm consists primarily of increased muscular tension. It also involves a psychological reaction which is essentially panicky. As a rule, the stutterer's post-spasm reaction consists of an effort to force out the sound with which he is having difficulty—an effort to break the spasm. Much of the stutterer's muscular strain and facial grimaces forms a part of his post-spasm reaction. Fundamental to both his pre-spasm and post-spasm reactions is his strong desire to avoid stuttering. In some instances the spasm and post-spasm phases overlap psychologically. They may proceed simultaneously except for the very first beginnings of the spasms. The pre-spasm and post-spasm reactions of the stutterer, if unfavorable—and they generally are—increase the frequency and intensity of the spasms. This is because the emotional reactions produce neurological changes which may result in a

[3]For a fuller discussion of this concept see Johnson, W. (31).

partial or complete dysintegration of the delicately organized functions of the cerebral cortices. The pre-spasm and post-spasm reactions of the stutterer are amenable to reeducation. The aim in dealing with these two phases of the stuttering process is to develop the stutterer's ability to react to a stuttering spasm without increase of effort or muscular tension, and to develop a matter-of-fact, objective, "adult" attitude which will enable him to exercise this ability without emotional upset. The aim is accomplished by teaching the stutterer to observe and evaluate his own stuttering and its social implications, his attitude toward the stuttering depending largely upon his observations of it, and by training him to react skillfully to the spasms without increase of effort or muscular tension. The training techniques involve speaking performances, including effortless reactions to spasms and to some extent deliberately simulated stuttering in graded situations ranging from those conducive to practically no emotionality to others conducive to intense emotionality. Paralleling these, the stutterer makes an analysis of audience reactions and subjective and objective factors responsible for emotionality. Practice speaking in controlled situations and analyses of what goes on both within the stutterer and his environment are the two main parts of the psychological method for the stutterer's gaining insight into his condition.

It should be said that most adult stutterers formed their present attitudes toward stuttering and the reactions growing out of those attitudes during early childhood on the basis of such inadequate observations as they were then able to make. Consequently, these attitudes and reactions are childish and inadequate. It is one of the prime objectives of mental hygiene to replace them with more adequate and adult attitudes based on observations of the greatest possible adequacy. The stutterer must learn to objectify and in some cases to accept his trouble. The common practice of shielding him has worked against instead of for him. Through powerful indirect suggestion it convinces him that he is "different," generally in the direction of being inferior and inadequate. He has been taught to keep his trouble to himself, and, as a consequence, he often becomes undesirably introverted. Let us and the stutterer acknowledge, first of all, that he has a defect and that he and we are going to study it. In this study we shall require that he become acquainted with his stuttering organism. He must know objectively how it looks and feels to stutter.

The psychiatrist recognizes the extremes of personalities in his cyclothymic and schizothymic patients. The "cylothyme" is characterized by the synergic, coordinated, rhythmic activities of the average extrovert. The "schizothyme" is characterized by the asynergic, incoordinated, arythmic activities of the average introvert. The cyclothyme is the actor; the schizothyme, the thinker. Speech is essentially social action. Other things being equal, the acting type of person is the better speaker than the thinking type of person. In managing the stutterer it is not a good plan to make him think more. The direction of management should be toward making

him act more.[4] The stutterer will enjoy freedom of expression to the extent that his expression partakes of the easy state into which his whole body is thrown. Total body activity should accompany his attempts at speech. Significant gesturing is very helpful. The stutterer should be taught to forget himself by trusting his own impressions and giving himself up to the purpose of sharing them with his fellows.

The psychological program is carried out in the home, school, and clinic. Conferences with the parents and teachers are invaluable. Assigning them pertinent articles and books to read is a good practice. Lectures on stuttering, psychology, mental hygiene, and physiology to both the parents and the stutterer are helpful. In the daily or weekly routine work with the stutterer, individual conferences and class work should be about equally divided. In the former, problems peculiar to the given individual are handled. In the latter, the stutterer gets a chance to give speeches to the group. Observation forms are distributed to the audience and they record thorough observations of the speaker's performances. The speaker also fills out observation forms both in regard to his own reactions and those of the audience toward him. These are to be compared with the observations made by the audience. In group work the object is not to train in public speaking, but to teach the stutterers to adjust themselves to the group and to their own handicaps.

In conclusion, we may say that the most helpful management of the stutterer comprehends the institution of all known aids for the stabilization of the human being. The remedies for each individual case vary in relation to the individual demands. A great deal of the success in speech training depends upon the teacher. What he or she needs most to acquire is a good personality and understanding of and sympathy with the stutterer's outlook on life.

Disorders of Articulation and Phonation

We consider here the several different speech disorders whose essential characteristics lie in defects of enunciation and voice production, including delayed development of speech.

The production of any single sound is a very complex act involving the use and coordination of every part of the speech mechanism. In every act of speech the entire speech apparatus is engaged. The conscious control of a small group of muscles is often easy of accomplishment when the child is not speaking, but such conscious control is generally lost when he starts to speak. The functioning of the entire speech mechanism in speech so excels in significance the conscious control of a limited group of muscles in this mechanism that it is futile to call the child's attention to the operation of a single part such as the lips. As a rule, any attempt to control a narrow group of muscles which constitute a part of the larger group will result merely in a wrong tensing of the former. An entirely

[4]Dr. John M. Dorsey of Michigan University reports good success in handling certain types of stutterers according to this (his) plan.

new total reaction pattern must be acquired in overcoming any articulatory difficulty. The correction does not amount merely to altering the activity of a single group of muscles, such as those of the lips or tongue, but to creating an entirely new movement on the part of the entire speech apparatus.

Basis of Classification of Disorders of Articulation and Phonation. In order for a person to have normal speech he must be adequately stimulated and possess a neuromuscular mechanism capable of responding to the stimuli given. There must be no defect in the entire mechanism from the sense-organs, through the on-relaying mechanisms, to the muscles, if normal speech is to result from ordinary environmental stimulation. If there is an abnormality any place in the mechanism, extraordinary means may be necessary to build up normal speech. The individual may present a deficiency in the sense-organs, in the on-relaying mechanism (nerves, brain), in the muscles, or in all three to operate as a cause or causes of disordered articulation. Some of these deficiencies are demonstrable, while others can only be inferred. It is possible, for instance, to determine deafness, certain lesions in the nervous system, and various lesions and anomalies in the speech muscles. The individual with a severe disorder of articulation in whom none of these can be demonstrated presents a problem in which physical defects or deficiencies can only be inferred. On the basis of determined or inferred organic pathology and the lack of such we classify disorders of articulation and phonation as organic and functional respectively. Of a number of cases presenting similar speech disorders some may be functional and others organic. This is particularly true of the children with delayed speech development which may be due to defective intelligence, bad training, glandular disturbances, or brain injuries. Here the speech defect may be considered functional if due to bad training, or organic if due to brain injuries.

Organic Disorders of Articulation and Phonation

a. Etiological factors. For practical purposes causal factors may be considered under two large heads, central and peripheral deficiencies.

Central deficiencies

Cerebellar lesions. Cases with cerebellar lesions reveal in their speech a characteristic slowness, drawling, and monotony of pitch pattern with a tendency toward scanning. In many cases the utterance is remarkably irregular and jerky. Utterances of many syllables, especially those which end a sentence, tend to be explosive. As a rule, phonation is more affected than articulation. There is a nasal quality to the voice. The great effort necessary to utter a series of syllables or a sentence is associated with excessive facial grimacing which gives speech a labored character.

Although these patients do not show any difficulty in forming different single sounds (both vowels and consonants), the pronunciation of the longer words, especially those of many lip sounds, causes great trouble.

They breathe almost entirelv with the diaphragm and show an incoordination in respiration which interferes with the normal integration of the entire speech mechanism (the inability to subordinate vegetative breathing to the meaning of speech). Neither the strength of the voice nor the interruption of speech by inspiration is regulated correctly to accord with the meaning of the spoken sentences. These patients usually start to talk with normal voice intensity, which decreases in a definitely steady fall to a point of exhaustion. The act of respiration is here seen to command the flow of speech. Speech loses its usual dominance over respiration.

Lesions in the cerebral hemispheres. Lesions in the dominant cerebral hemisphere (the left hemisphere in right-handed individuals and the right hemisphere in left-handed individuals) have a greater effect on speech and allied functions than do lesions in the non-dominant cerebral hemisphere. Since the effects of the former will be discussed under aphasia and allied disorders of speech, we shall confine our attention here mainly to effects of injuries to both cerebral hemispheres. Injuries to the non-dominant hemisphere do not produce such specific effects as do those of the dominant hemisphere. If the lesion is in the motor area of the non-dominant hemisphere, articulation will be slurring, indistinct, and thick because of the physical interference which the paralyzed half of the tongue, lips, and cheek muscles cause. The voice will likewise be thick and indistinct.

In multiple sclerosis, although the pronunciation of the word is clear, the tone is monotonous. The whole production is characterized by scanning and a staccato form of utterance. The scanning often found is probably due to cerebellar lesions. The patient has been described as speaking like a child spelling out his letters.

In dementia paralytica the speech is slow, halting, uncertain, stumbling, slurred, and irregular. There is a marked tendency to slight words and syllables. Accompanying the mechanical defect in speech there is often a loss of memory and a progressive enfeeblement of all of the intellectual powers so that the picture becomes quite complicated.

Lesions in the corpus striatum. The speech in paralysis agitans is usually slow. In speaking the patient shows great deliberation and marked hesitancy. Sometimes the speech shows the festination more common to the patient's gait. Along with this change in speech the voice becomes shrill, high-pitched, and piping.

The speech in Wilson's disease (progressive lenticular degeneration) may not suffer internally. The patient will have trouble in articulating because of the hypertonus of the muscles of the jaw, lips, tongue, and pharynx. Skilled acts of other sorts may be performed, but there is a definite interference with the control of all volitional motions occasioned by the stiffness of the muscles.

Lesions in the bulb. In progressive bulbar paralysis (glosso-labio-laryngeal paralysis) there is progressive atrophy of the motor neurons of the ninth, tenth, eleventh, twelfth, seventh, fifth, and sometimes of the

sixth and third cranial nerves. The functions of swallowing, coughing, and talking are affected. In general, the patient's speech is nasal. The voice may become hoarse. Gradually his speech becomes more indistinct, more labored, and, finally, unintelligible. The principal mechanical difficulty due to a paralysis of the throat, tongue, and lip muscles is an inability to manipulate the organs of articulation in the formation of the sounds. The patient makes extraordinary efforts to speak and raises his voice to an unnecessarily high pitch.

Miscellaneous disturbances. In chorea the speech is jerky and irregular. Being affected by the abnormal breathing movements of the patient, the words come forth in a violent and explosive manner.

In myxedema the speech is slow, rough, and monotonous.

In epilepsy the speech is sometimes monotonous, thick, and indistinctly enunciated.

Peripheral deficiencies. The peripheral deficiencies are deficiencies in the sense-organs and the muscles. We may list the following as peripheral causes of disorders of articulation and phonation:

Tumor of the tongue
Macroglossia (abnormally large tongue)
Microglossia (abnormally small tongue)
Tongue-tie
Hemiatrophy of tongue
Cleft-palate
Abnormal length and thickness of uvula
Double uvula
Improper development of palatal arch
Imperfect dental arches
Harelip
Enlarged adenoids and tonsils
Deformities of the jaws
Nasal polypi
Hypertrophied turbinates
Marked deviation of the septum of the nose
Stenosis of the larynx
Chronic laryngitis
Sinus disease
Post-diphtheritic paralysis
Defective teeth
Perichondritis of the laryngeal and nasal cartilages
Defective hearing

Abnormalities of the tongue. There are no established standards regarding the size, shape, and motility of the tongue. Certain marked deviations from a somewhat loose standard may, however, be considered as abnormal. In general, any tongue which cannot be extended beyond the teeth is not free enough for good speech. Theoretically, a tongue-tie

would affect every sound. Practically, it has the most effect upon those sounds which require the air to be completely or largely shut off at the anterior part of the oral cavity. For instance, an (s) will become (θ). Faunce (17) has made a study of the relation of the size of the tongue to its control in articulation. He found that the distance from the anterior end of the frenum to the tip of the tongue is shorter for defectives than for normals. The anterior free portion of the tongue of the defective is thus apparently too short for the required rapidity and variety of movements demanded in correct articulation. In certain cases, however, it is too long. Here it acts to interfere not with the correct production of individual sounds but with the bringing of sounds into connected speech. A large percentage of Faunce's cases had very large tongues in relation to the lower jaw. There appeared to be consistent differences between defectives and normal speakers in regard to the shape of the tongue. The shape of the normal speaker's tongue-tip when pointed is rather uniform throughout. In the defective it is often quite irregular, one side being markedly different from the other.

Tumors of the tongue not only reduce its motility but act as foreign bodies in the oral cavity. They cause speech to be thick and indistinct.

Abnormalities of the uvula. Abnormalities of the uvula may be listed under abnormal length and thickness, bifurcation, and double uvula. They interfere with the functioning of the organs of articulation by causing the uvula to act as a foreign body in the pharynx and by pulling down on the soft palate to prevent its rising in the production of the vowels. Due to them speech is muffled.

Intranasal obstructions. The most common intranasal obstructions are hypertrophied turbinates, deviated septums, and polypoid growths. They interfere with head resonance to change the quality particularly of the nasal sounds. (m) tends to become (b); and (n), (d). Often nasal obstructions are only temporary, as in severe colds, when the turbinates become swollen and the nasal cavities are more or less closed.

Cleft-palate and harelip. These two conditions are closely associated. Speech with cleft-palate is the opposite of that with intranasal obstructions. In the former type there is excessive nasalization as there is no velum or only a defective one to close the rear passage through the nose. Due to cleft-palate and harelip all sounds change their quality. (m), (n), and (η) are the least affected. So-called explosives become nasal, as do also the vowels.

A high palatal arch effects mainly the (s). The individual has difficulty in getting the tongue properly against the palate to produce the small air channel. Sometimes he permits the air to escape at the sides, while at other times his attempts to press the tongue up tightly leads to a strong spasmodic pressure at every (s). Often he has no (s) at all.

Abnormalities of the teeth, jaws, and dental arches. Correct form of the dental arches and proper occlusion of the teeth are necessary for perfect speech. The teeth, although passive, play a very important

rôle in speech. It consists mainly of obstructing the clear passage of the breath in certain sounds. Great protrusion of the upper teeth and dental gaps affect the production of (s). Undershot jaws affect the sounds (f), (v), (p), (b), (m), (w), (υə), (ʍ), (α), and (o). Overshot jaws affect all of these sounds plus the sounds (ð), (θ), (s), (ʃ), (t), (tʃ), (z), (ʒ), (d), and (dʒ). An open bite affects all sounds with the exception of (η), and (h). Obtruded front teeth interfere with the sounds (f), (ð), (θ), (s), (ʃ), (z), (v), (ʒ), (ʍ), (p), (υə), (o), (w), (b), and (α). Intruded front teeth interfere with the sounds (ð), (θ), (s), (t), (z), and (d).

Adenoids. Adenoid vegetations may cause defective articulation and phonation directly by bringing about a relaxation of the soft palate and preventing its normal activity in talking or by interfering with the head resonance to make the voice muffled and indistinct. When a person has large adenoids, the closure of the velum is made against them. After they have been removed, the velum may continue to make the same amount of movement as before. This leaves a gap between it and the rear wall of the pharynx which causes all sounds to be nasalized. Thus, not only the presence of adenoids but the relaxed palate after their removal may cause defective phonation.

Defective hearing. It is through the ears that we receive our most important source of stimulation for the development and maintenance of speech. A congenitally deaf child will not learn to talk of its own accord. Often a child who is learning to speak will gradually stop developing further because of acquired reduction in hearing. Acquired deafness in adulthood has a marked effect upon the individual's speech. Due to it he fails to grasp the finer essentials of the sounds.

b. Understanding the organic disorders. Study of the individual for the understanding of organic disorders should comprise medical, mental, hearing, and speech examinations.

Medical examination. A thorough medical examination is of paramount importance. The speech pathologist should be informed of the nature and extent of the organic disturbances before any remedial exercises are undertaken. In most cases not only should the patient be examined by the medical expert, but he should be treated by him before the speech specialist begins his work. When a history is obtained that the child talked at one time but gradually ceased to develop, medical examination should be made to rule on such factors as enlarged tonsils, deformities of the hard palate, adhesions of the tongue to the anterior pillars or epiglottis, partial paralysis of the tongue, decrease in hearing, and so forth. Before the speech teacher begins her work, the entire speech apparatus should be put in the best possible condition. Tonsils and adenoids may have to be removed, the frenum cut, the teeth straightened, and the palate closed. Here, as in all other types of speech defectives, the general physical condition of the child must be carefully studied. Realizing the importance of the teeth in normal speech, the speech teacher

should have the advice and help of the oral surgeon or dentist who could contribute to the proper handling of the case.

Intelligence examination. A reliable rating of the patient's intellectual capacity should be obtained. A great many patients with organic disorders of articulation are mentally defective as well. A prognosis will have to take this factor into consideration. A patient with a cleft-palate and defective intelligence is not hopeful from the standpoint of achieving good speech. One of my patients who was a very superior student with practically no hard or soft palate had almost normal speech before any formal training whatsoever was begun. Mentally defective children (refractory to training) with only a small cleft often present very faulty speech.

Hearing examination. Hearing is so important for the establishment and maintenance of speech that special reference ought to be made to tests of auditory acuity. There are two sensory properties of tones, pitch and loudness. These are directly related to the specific physical properties, frequency and intensity of vibration of the air particles of the transmitting medium. Some psychologists hold that there is a third sensory property of pure tone, namely, volume or extensity of the tone. It is related to both intensity and pitch. Complex sounds may be considered as combinations and variations of pure ones. Vibrations in the sound wave communicate mechanical vibrations to the eardrum. These are the stimuli which when communicated to the inner ear excite nerve endings to set up nerve impulses. The nerve impulses are conducted by way of the auditory nerves to the brain. For all of this to happen efficiently there must be a normal receiving and conducting mechanism. If there is any defect in any part of this mechanism, the brain will not be properly stimulated. The fine shades of differences between sounds have to be faithfully relayed through the entire receiving mechanism if normal speech with its widely varying properties is to develop.

When the intensity of a sound is continuously decreased, it reaches a value where it produces no auditory sensation. That intensity which is just sufficient to be heard is called the "threshold of audibility." It is the lower intensity limit of audition. If the intensity is continuously increased, it reaches a value where it produces the sensation of feeling. This intensity is called the "threshold of feeling." Intensities higher than this cause pain and injure the hearing mechanism. The "threshold of audibility" is dependent upon the pitch of the sound. If a tone is kept at a given intensity and at the same time gradually raised or lowered in pitch, it ceases to be heard by the individual at both an upper (approximately 20,000 cycles per second) and a lower (approximately 20 cycles per second) pitch limit. Hence, most testing devices properly evaluate both the pitch and the loudness of a tone.

To determine the person's ability to hear sounds of various loudnesses and pitches, highly refined instruments have been developed. They usually go under the name of "audiometers." Although each person has a hearing

acuity which is more or less peculiar to himself, there are certain limits within which a person must fall to be considered normal. The hearing loss is measured by the threshold shift from the average threshold-intensity level for normal ears. If the examiner wishes to know the percentage of hearing loss for speech rather than that for pure sounds, speech sounds may be used in making the test. The whole subject of speech and hearing is adequately treated by Fletcher (18).

Speech examination. The speech examination proper will concern itself with determining just what particular defects the patient has. It should be based mainly upon unemotional propositional speech. Additional information may be gained from having the patient read, recite memorized material, or repeat after the examiner. The main tool of the speech pathologist in diagnosing disorders of articulation is a trained ear. He should be able to detect abnormalities in the rate, rhythm, quality, and amount of speech by listening to the patient talk. The same thing applies to abnormalities of the voice. Here the examiner should be able to detect defects in the quality, duration, pitch, and intensity of tones. A well-equipped laboratory for the recording of the speech and voice of defectives is very helpful.

c. *Management of organic disorders.* The great majority of the organic cases should be handled either entirely or at least first by the medical expert. There is little the speech pathologist proper can do with patients who have dementia paralytica, Friedreich's ataxia, or Bell's palsy. Where there is a multiude of pathological causes, without the help of medical and surgical treatment little can be accomplished by the teacher. In the public schools the teacher should realize that in a great many cases she is dealing with a pathologic condition. She should take the child for serious speech training only after he has been thoroughly examined by a competent medically trained man.

The importance of medical treatment. When it is fully realized how closely speech pathology is associated with neurology, otolaryngology, psychiatry, and psychology, the teacher will protect herself against possible mistakes by basing her work upon the findings of the experts in these various fields. Let us take the instance of hypo- or hypernasality. The former may be due to sinusitis, hypertrophied tonsils, enlarged turbinates, deviated septum, enlarged adenoids, nasal polypi, or a combination of some of these, while the latter may be due to cleft-palate, post-operative tonsil trauma, relaxation of the palate in the aged, postadenoidal speech, velar insufficiency, or any combination of these. On the other hand, they may be the result simply of bad habits. With the etiology of nasality in mind, the teacher should see the advisability of obtaining medical assistance. It is improper for her to attempt an examination of the nose and throat. Without careful training she will be unable either to use the instruments employed in such examinations or to interpret what she sees. Let us consider also the common type of speech defect known as lisping. It may be due to missing teeth, harelip, lip paralysis, short frenum,

microglossia, macroglossia, prognathism, arched narrow palate, cleft-palate, improper dental arches, obstructions in the nose and throat, weakness of the tongue muscles, malocclusion, and paralysis of one side of the soft palate. Some of these cannot be remedied by anyone, but the teacher should have the benefit of a medical and dental examination before any corrective training is undertaken. After everything possible has been done to put the entire speech apparatus in good condition the teacher should attempt to give the patient the best speech she can with what the patient has left to produce it.

Exercises for weak and relaxed muscles. In the case of simply weak and relaxed muscles (lips, tongue, soft palate) certain exercises may be used. Those in common use in speech pathology follow:

TONGUE EXERCISES

1. With the tongue pointed, move it outward and downward toward the chin.
2. With the tongue pointed, move it outward and upward toward the nose, touching the nose if possible.
3. With the tongue protruded between the lips, wag the tip up and down as rapidly as possible.
4. Rotate the tongue around the outside of the mouth. This should be done in both the clockwise and counterclockwise direction.
5. Protrude the tongue and form a groove through the center by raising both sides. Some individuals are able to form a tube in this manner.
6. With the mouth wide open, curl the tip of the tongue back of the upper teeth.
7. Press the tip of the tongue against the backs of the lower teeth until it rolls forward and outward between the upper and lower front teeth.
8. Move the tongue in and out of the mouth as rapidly as possible.
9. Press the tip of the tongue against the backs of the upper teeth until it rolls forward and outward between the upper and lower front teeth.
10. With the tongue pointed, dot the roof of the mouth in three places, the front middle, and back.
11. Scrape the roof of the mouth with the point of the tongue going from front to back.

LIP EXERCISES

1. Protrude the lips in a puckered position.
2. Extend the upper lip outward and upward to touch the nose.
3. Pull down the lower lip, exposing the lower teeth.
4. With teeth closed say *ah-oo-ee-oo, ah-oo-ee-oo* slowly and with vigorous lip action. Round the lips for *oo* and stretch them for *ee*.
5. With the teeth separated and with the mouth wide open repeat the exercises.
6. Say *we-woe-we-woo, we-woe-we-woo* with exaggerated lip action. Be sure that the lips are spread as in smiling for *we* and are rounded for *woo*.

SOFT-PALATE EXERCISES

1. Say *ah*.
2. Yawn (patient notes rising of palate).
3. Say slowly, emphasizing each sound, *ung-ah, ung-ah, ung-ah; ump-ma, ump-ma, ump-ma*.
4. Imitate the ringing of a bell, *ding-dong, ding-dong, ding-dong,* prolonging the *ng* softly.
5. Say *ing-ick, ing-ick, ing-ick,* prolonging the *ng* and making the *k* stop short and sharp.

The patient must reorganize his speech apparatus into a new whole. The success of phonetic drills for most cases of organic disorders of articulation is somewhat limited. In very few patients is perfect speech ever

acquired. In some cases the organic defects are such that the proper formation and combination of certain sounds in speech are absolutely impossible. The needed structures are simply not there. The patient's job is to reorganize his entire speech apparatus into a new whole which in most instances will be fundamentally different from that of the normal. In this view one can see the futility of trying to get him to talk as the normal speaker does. The goal in all reeducation programs is to give the patient sufficiently standardized speech to make himself readily understood. Most of the exercises commonly used in dealing with organic cases direct the patient's attention to limited groups of muscles. The cleft-palate case, for instance, has the greatest difficulty with (p), (b), (m), (w), (f), and (v). He is instructed to make a definite closure and pressure of the lips, or to place the lower lip against the upper teeth, and so on. These are obvious things to do, but the teacher forgets that the rest of the speech mechanism is involved and, further, that the whole apparatus functions as a unit and should be handled as such. Hence, I would suggest that here, as with the functional cases, she resort to stimulating the individual with speech sounds through the auditory channels and minimize instructing him how to place this, that, or the other part of his speech apparatus. The stimulation method is taken up in greater detail in the following section.

Functional Disorders of Articulation and Phonation

a. Etiological factors. Speech defectives in whom no defects in any part of the speech mechanism (sense-organs, central nervous system, and muscles) exist are assigned to the functional group. The chief etiological factors in functional disorders are mental deficiency, faulty training, short auditory memory span, and idiopathic defects. By no means do these exhaust all possible etiological factors. As we learn more about speech defects we shall gain more insight into what causes them. Without doubt, at the present time, there are a great many causal factors concerning which we know nothing.

Mental deficiency. A serious defect of general intelligence will gravely affect the functional efficiency of the individual. Intelligence, whatever it really may be, is a basic instrument of control and adaptation. A number of investigators have found that speech is acquired more slowly and is more subject to disorders in the mentally deficient and retarded than in the normal child. For example, Wallin (72) reported that for both sexes single words were used at one year of age by normal children but not until 1.8 and 2.0 years by subnormal and feebleminded children respectively. Short phrases and sentences were spoken by the same groups at the ages of 1.7 and 2.6 and 3.0 years respectively. In regard to single words, feebleminded children, as compared with normal children, presented a retardation of 95 per cent, and for short phrases or sentences a retardation of 76 per cent. Further, Wallin found that only 2.8 per cent of the children in the regular grades presented speech defects while 26.3 per cent of those in the special schools for the mentally deficient had such disorders. Travis and Davis (62), in a study of 546

university freshmen, reported that normal speakers were superior in intelligence to speakers with functional disorders of articulation.

Kennedy (33) made a study of 249 morons (ranging in intelligence quotient from 50 to 69 inclusive), 32 imbeciles (ranging in intelligence quotient from 21 to 47 inclusive), and 32 idiots (ranging in intelligence quotient from below test level to 20 inclusive). All of the idiots, all but one of the imbeciles, and 42.57 per cent of the morons were found to have some form of speech disorder, including mutism and delayed speech development.

Such findings as these are in harmony with the general concept that good speech, being dependent upon the efficiency of the unitary organism, suffers from any relative reduction of that efficiency such as a decrease in general intelligence.

Short auditory memory span. Auditory memory span is the term used to denote the number of presentations given orally by the examiner that can be returned correctly by the child. If a child is able to repeat without error one series out of three equal series of digits, consonants, or nonsense syllables given orally, the longest such series that he is able to reproduce correctly is accepted as his auditory memory span. The average three-year-old child has an auditory memory span of 3 digits; the average four-year-old child, of 4 digits; the average seven-year-old child, of 5 digits; the average ten-year-old child, of 6 digits; the average fourteen-year-old child, of 7 digits; and the eighteen-year-old individual, of 8 digits. The auditory memory span for logical sentences is considerably longer than that for digits, consonants, or nonsense syllables, being about 7 syllables at the age of three, 12 syllables at the age of four, 16 to 18 syllables at the age of six, 20 to 22 syllables at the age of ten, and 28 syllables at the age of sixteen. Robbins (50) has found that many cases of functional disorders of articulation have short auditory memory spans, which appeared related causally to the speech defects.

Faulty training. Another cause of functional defects of articulation and phonation is faulty training or a poor speech environment. If a child hears "baby talk" he is very apt to ape it. Unwise parents often give their children this type of stimulation. It is fortunate that a large majority of "baby talkers" outgrow their defect because of correct stimulation from other than parental sources.

Thomas (55), in a study of dialect, found that the New York Jew dentalizes the alveolar consonants (t), (d), (n), (l), (f), (z), overaspirates (t), has various difficulties with (s) and (η), and has a drawling, throaty, vocal quality because he is Jewish.

Functional hyper- and hyponasality are often matters of environment. We find them to be a family characteristic, passed on as a social inheritance for several generations.

Idiopathic defects. Even from a complete study of the individual, including every phase of his development and background, it is often impossible to assign his speech or voice defect to any known cause or causes.

Since the scientific viewpoint posits that nothing is accidental, one is led to believe in such cases either that the lack of positive historical data is not conclusive or that the method of examining the individual himself has been inadequate.

b. Understanding the functional disorders. General examination methods should be carefully carried out. These include a study of the individual's hereditary background, early developmental factors, intelligence level, school progress, and conditions in the home and school. In addition to these general methods certain clinical tests have been developed to aid in the diagnosis of articulatory difficulties. As we have stated before, the speech pathologist's best tool is a trained ear. He needs, however, certain more or less standardized sets of examining material to cover all possible sound omissions and substitutions and to determine the individual's ability to hear and produce speech sounds.

Determining patient's understanding of spoken language. In examining the individual, particularly the child, the first thing to learn is whether or not he understands simple spoken language. This may be accomplished by having him point to various parts of his body and obey simple commands. More complicated questions and statements may be put to the adult. The neurologist must make a differential diagnosis to distinguish between functional disorders of articulation (dyslalia) and aphasia. One may confuse very mild cases of certain varieties of the latter type of speech disorder with a combination of a certain amount of delayed speech development and certain articulatory abnormalities. In the case of adults the history may settle any doubts about the diagnosis. No standardized tests relative to speech-comprehension age level based on ability to "see" audile relationships have been devised. The examiner will be obliged, therefore, to use his own ingenuity in making this part of the examination complete.

Examining propositional speech. Propositional speech should be examined in several ways. The individual ought to be observed in easy, free, unemotional speech situations in which he is not under any unusual emotional strain. By leading questions and remarks the examiner may direct the individual's talk to cover as completely as possible the various sounds, sound blends, and sound combinations. Certain standardized situations have been developed to supplement this type of observation. They consist largely in presenting the individual with a set of pictures which are designed to call forth words containing all the consonant and vowel sounds in their initial, medial, and final positions. Such a test has been devised for children by Miss Clara B. Stoddard of the Detroit Board of Education. It is known as Articulation Test I. The child says the word suggested by each picture. A score sheet is furnished to tabulate the child's errors or omissions.

Testing reading. In nearly every instance it is not only advisable but necessary to have the individual read. The examiner wants to know if the patient has the same difficulty in reading as in speaking. Further,

the other methods of examination may have failed to cover all sounds. Materials of the proper difficulty for the individual's age and intelligence level should be selected. Miss Stoddard has prepared two lists of short sentences which include all sounds. One list, which has 45 sentences, is called Articulation Test II; the other list, with 37 sentences, is called Articulation Test III. Each test is provided with a score sheet.

Testing repetitive speech. It is advisable to study the repetitive speech of the individual. This may be done by having him recite material he has memorized. In the case of children Mother Goose rhymes are satisfactory.

Testing ability to imitate speech sounds. More to determine early in the study of the individual his ability properly to imitate speech sounds than to classify his speech difficulties, he should be required to repeat after the examiner. One may use the reading material for this purpose. The individual is asked to repeat what the examiner says or reads.

Testing speech-sound discrimination. In dealing with speech defectives it is important to know whether the individual's inability to form a sound correctly is due to some motor or some sensory disability. There is no doubt of a close relationship between hearing and both the development and the integrity of speech. If it appears in the earliest period of life, total deafness or badly defective hearing has a very unfavorable influence on the evolution of speech.

One attribute of good hearing is sound discrimination. In relation to speech this involves a judgment calling for distinction between meaningful speech sounds. It may be said that the individual attaches different meanings to different sounds provided, first, that he hears the sounds, and, secondly, that he discriminates between them.

Travis and Rasmus (68) have devised a test which requires the individual to distinguish between sounds. In it the sounds are compared on the basis of a likeness or a difference in quality. The intensity, duration, and pitch of the sounds are held constant. From a study of 569 individuals (383 normal speakers and 186 speech defectives) of all ages they found that at every compared age level individuals with mild functional disorders of articulation made significantly more errors than did normal speakers. None of the cases presented motor disturbances or disabilities of any kind. This indicates that the functional type of case has inferior speech-sound discrimination ability.

Motor coordination of speech muscles. As with the stutterer, the articulatory case very frequently shows inferior ability in controlling the lips, tongue, jaw, and diaphragm in voluntary rhythmical movements not involved in speech. This would imply, as does the speech defect itself, that he possesses poor control of these structures in speech. The examiner should get some estimate of the amount of reduction in the patient's motor control and coordination. A good way of obtaining this is to record the movements of these parts on a kymograph or polygraph. If it is impossible for the examiner to record the movements of the various structures,

he may judge their rate and regularity by direct observation. For the tongue, the patient is asked to place the organ against the free edge of a piece of paper held in his hand and move the tongue backward and forward as rapidly and regularly as possible, taking care to keep it against the paper all the time. By comparing the patient's performance with that of a normal speaker the examiner can quite accurately determine any marked motor disability. In the case of the lips, the patient is asked to move them as in whispering (p) or (b); in the case of the jaw, he may raise and lower it as in biting; in the case of the diaphragm, he is asked to pant. In all of these activities speed and rhythm should be emphasized.

c. Management of functional disorders. The speech pathologist should realize that in learning the individual goes from the more general to the more specific modes of behavior. This means that a sound is the very smallest possible unit with which to deal. It should not be broken up into the movements out of which one might suppose it to be built. To break up the unity of movement in a sound or a set of relationships in speech production may give false evidence of progress.

Repetition of stimuli the important factor in learning. Learning is more than a function of repetition of response. It is a question whether such repetition should be at all construed as a causal factor in the learning process. We might say that, instead of the individual's learning by acting, he acts to see if he has learned. In speech and song we have evidences on all sides of us that new responses are made correctly the first time. It is easily demonstrated that an individual may so learn a tune by just listening to it that he produces it correctly the first time he attempts it. When we attempt to sing a song, we may be doing so to see if we can sing it and not to practice it. We do not learn it by drilling but rather by hearing it. From the standpoint of acquisition of a pattern of response (learning) it is probably the repeated stimulation that is helpful. In so far as the response has a circular effect, to the same extent this required stimulation is furnished, and, in learning, the response may be considered helpful to the same extent that its expression renews the stimulus pattern. The speech defective should therefore be subjected to properly timed and properly given stimuli. In his case the stimuli are sounds given by the teacher.

The method for stimulating the child. Experimental evidence is lacking on this point, but our experience leads us to believe that a sound with which the individual is having difficulty should be produced for him by the teacher at least five successive times with about a second between each production. Following a pause of a few seconds at the end of the series, the patient may be asked to make one trial to see if he can now make the sound correctly. If he cannot, then the teacher should give the sound five times again, and so on, until the child can form the sound properly the first time. After he has given it once correctly he may then repeat it. The effect of drill, formerly thought to be the outstanding factor in

learning, may act to sterilize the insight of the learner and to kill his interest in the task. We do not want drill words on which the speech defective stumbles, but stimulus words given by the teacher which he thus always hears accurately. He grows to a more normal and perfect production of the sound between perfect stimuli.

When working on one sound it is not advisable to undertake work on another until the child has had time to mature in regard to the first one. This is particularly true if the second sound is closely related to the first. For some time the child is still behaving with reference to the original task. His response is unfinished, immature. New activities may not conform to the original configuration which, still demanding completion, incorporates foreign responses.

In learning, perceiving the goal is important. A correct sound formation is not based upon an elimination of so-called random "trial-and-error" movements, or upon a successful combination of such movements, but upon an entirely new movement unit. The child should not think about the movements as such or, like the centipede who was quite happy until asked which leg came after which when he began to run, he will be wrought to such a pitch that organized activity will be impossible for him. He should, however, strive to perceive the goal, the end-product in its totality. Once this configuration is completed, the movements take care of themselves. At the outset the goal (proper sound formation) may be very vague and indefinite. The child may not be able at first to perceive a sound in relation to the means of producing it. He makes his initial move and immediately finds himself in error. But, as he matures by being properly stimulated, the goal becomes clearer until finally he correctly produces the desired sound. Maturation is a differentiation of stresses in the nervous system which makes possible the construction of new reaction patterns.[5]

These suggestions for retraining do not rule out the advisability of calling the child's attention to obvious misplacements of the organs of speech. If a child is placing the tongue too far forward or too far up in his attempts to produce a certain sound, his attention may be called to the error.

Stimulus material. Travis (59) has supplied us with a list of stimuli in the form of nonsense syllables, words, and sentences designed to include the main sound blends and each sound in its three possible positions (initial, medial, final). The teacher is to say these words and the child is to watch and listen. It is best for the teacher to give five stimulus words (in the case of the sentences, only one) before asking the child to respond. These words are stimulus and not drill words. The pupil should not use them as practice words until he is able to make the sounds correctly. If, after a series of five stimulus words, he is unable

[5]For a fuller statement of the laws and facts of learning see R. H. Wheeler (75).

to make a sound correctly the first time he tries it, the teacher repeats the series and again asks for just one response, and so on, until the pupil is able correctly to form the sound. As soon as the stimulation has correctly shaped the pupil, he will be capable of furnishing himself with it in speech. There should always be a pause between the last stimulus word and the pupil's response. The maturation process continues for some time after the stimulus ceases to act.

Particularly after the child's defect has largely disappeared, or even from the beginning in the case of the adult speech defective, the sentences may be used to good advantage. The teacher should read aloud a sentence and then ask the listener to repeat a designated word. After the listener (child) is able to produce the desired sounds correctly, he may read aloud the sentences.

Disorders of Symbolic Formulation and Expression (Aphasia and Kindred Disorders)

Disorders of symbolic formulation and expression consist essentially of a lack of power to execute with ease acts connected with articulated speech and the comprehension of spoken words. The aphasic patient is robbed of certain forms of effective symbolic representation and has lost the usual means of communicating with his fellows. A severe case may be deprived of articulated speech, of the comprehension of spoken words, and of all the complex activities associated with words (such as reading, writing, and the use of numbers). Happily, however, few aphasics show such profound loss of functions connected with speech.

Cases presenting disorders of symbolic formulation and expression differ profoundly in their clinical manifestations. The majority, especially in their earlier stages, evince widespread defects in the use of language and are not readily divisible into groups. In the later stages certain aspects of symbolic formulation and expression remain affected and the so-called aphasia consequently assumes some particular form. Such forms show the way in which a highly complex series of rhythmical acts can be disturbed by lesions of certain portions of the brain. No two cases are exactly alike, for the form assumed by the disorder of speech depends not only upon the site, severity, and nature of the lesions, but also upon the intelligence and the extent of education of the patient. The clinical phenomena represent the mode of response of any given individual to an abnormal situation, produced by some disturbance of structure or function. Broadly speaking, however, cases of aphasia may be divided into four clinical groups according to Head (26), as follows: verbal defects, syntactical defects, nominal defects, and semantic defects.

Verbal Defects. The verbal variety of aphasia consists mainly of a defective power in forming words. However fluent these patients may ultimately become, they always find difficulty in pronouncing words. Words of more than one syllable tend to be slurred and shortened. It must not be supposed that the loss of function in such cases is purely articu-

latory. Even though the patient remains silent and makes no obvious movements of his articulatory apparatus, any process of thinking that demands fluent verbalization is affected. He cannot produce with certainty the word he requires either for internal or external speech. Silent word formation may be profoundly disturbed and show the same defects as verbalization.

A characteristic feature in severe cases is an inability to reproduce words which may otherwise be uttered under the influence of some appropriate occasion or emotion. As recovery advances, this power of reproduction rapidly returns.

The lack of free and fluent internal verbalization is liable to interfere with the power of silent reading. Writing shows defects analogous to those of articulated speech in that they consist mainly of faults in spelling and word formation. The ability to say the letters of the alphabet and the numerals is affected. Drawing is not affected. One of the most striking faculties possessed by the verbal aphasic is the power of recognizing his errors. Upon reading over what he has written to dictation, a patient may notice many of his errors and omissions and attempt to correct them more or less successfully. Further, he may struggle laboriously to correct his defective articulation.

Syntactical Defects. In the syntactical variety of aphasic disorder the individual words may be recognizable but the grammatical structure of the phrase is apt to be badly affected. The patient talks fluently in short, jerky sentences, slurring or omitting many of the junction words. Moreover, he talks extremely rapidly, so that his utterance leads to indistinct enunciation even of smaller words. He does not, as a rule, go back to correct omissions or faulty enunciation but rushes on in the hope that he will be understood.

The main characteristic of this type of disorder is that the patient's talk is jargon. In silent reading, the meaning is hampered by the disorderly structure of the phrases of internal speech. In reading aloud, all of the troubles of articulated speech appear in a severe form. Some patients show a tendency to read from right to left. Writing suffers on the whole less than does external speech. The power to write from dictation is affected in writing consecutive phrases but not in writing isolated words or sentences. Except at a very severe stage of syntactical aphasia, the patient can count freely and shows none of that hesitation in finding the correct word so obvious in nominal aphasia.

In this type of disorder speech becomes a series of disconnected categorical statements. The articulatory balance of words or word groups is affected, and the structural form of the phrase is disordered from lack of those verbal elements which knit it together.

Nominal Defects. In the nominal disorder of symbolic formulation and expression the patient does not have difficulty in shaping words and phrases but rather in detecting their nominal significance. Although his enunciation is normal, he cannot with ease find the word or expression

he requires. So far as he can find words, they are enunciated correctly and united into coherent phrases. He presents mainly an inability to designate objects in words and to appreciate word meanings. Silent reading also suffers. These patients read to themselves but with great slowness and uncertainty. They are particularly liable to grave misunderstandings. Reading aloud seems to add to their difficulties. Spontaneous writing is greatly reduced.

Semantic Defects. Patients suffering from the semantic type of disorder display a lack of power to combine details into a coherent whole. They present a lack of comprehension of the significance of words and phrases as a unit. The general conception is faulty although details may be correct. The crude acts of speaking, reading, and writing may not be materially affected, but the patient is liable to fail in any task that demands for its performance precise formulation or expression in words or action of a general aim and intention. He suffers from no difficulty in pronunciation or disturbance in syntax. Purely verbal repetition is not affected. He can name common objects. The fault is essentially a want of recognition of relative significance and intention. The greatest difficulty is experienced, therefore, in understanding the meaning of a picture, the point of a cartoon or joke, or the significance of a story. The patient will point out one thing after another in a situation but fail utterly to combine the details into a coherent whole. In reading to himself he is very apt to miss the general sense of the argument. In his writing this same tendency is manifested. For him counting is easy and the numbers are perfectly pronounced, but arithmetical calculations are a great trouble to all of these cases. Coins may be named correctly, but profound difficulty is experienced in formulating their relative value in a direct statement. As a rule, spatial orientation is gravely affected. Such a case cannot play games such as chess, cards, or dominoes.

Methods of Examination. Clinicians are too often confused by contradictory reports from examinations of the same case by different men. If they fully realized that an inconstant response is one of the most striking characteristics produced by a lesion of the cerebral cortex, a good deal of perplexity would be avoided. Disorders of speech due to cerebral injuries reveal a marked want of constancy in their symptomatology. Bearing this in mind, Head (26) devised a series of tests in which the same task recurs on two or more occasions. Further, he arranged the tests so as to make the patient respond to them in several different ways. The order in which each single test follows another in a series remains the same throughout the whole examination. This makes it possible to draw conclusions from the inconstant responses and to learn how the patient responds to the same sequence of tests presented to him in different ways. Head found it important to graduate the severity of the tasks in order to determine to what extent the patient can speak, read, or write. It is important to record the rate as well as the nature of the response.

The introspections of the patient in regard to the ease or difficulty he had in carrying out the tests often prove of value.

All results should be interpreted in terms of the patient's background before his injury. For example, it would be more significant for a former accountant to fail completely to solve simple arithmetical problems than for an uneducated farmer lad to fail in these operations.[6]

Locations of Lesions in the Various Types of Defect. There is no doubt that speech can be disturbed by destruction of brain tissue and that the manifestations of the disturbance differ according to the locus of the lesion. These two facts have been repeatedly cited to prove the existence of "centers" for different aspects of speech. It is believed, however, that the older conception of a center as a specially restricted deposition of cells which initiates and carries out the motor or auditory phase of speech is wrong. Brown and Sherrington (6) have shown in the anthropoid ape that the response from one cortical point is not constant. It varies both in the nature of movement evoked and in the part of the body carrying out the movement. This finding was amplified still further by Leyton and Sherrington (35) who found that the motor area can be extended and that the area from which a particular response can be provoked may be considerably enlarged. In addition, the nature of the response can be reversed either by repeated excitation of the same point or by a previous stimulus applied to the same point which ordinarily yields an opposite movement. These workers concluded that the cortical motor points are functionally unstable and that this indicated an enormous wealth of mutual associations to exist between different portions of the motor cortex.

Lashley (34), in his work on the influence of the extent and locus of cerebral destruction in the rat upon a variety of functions, concluded that the same retardation in learning is produced by equal amounts of destruction in any of different cortical fields. In general, the amount and not the locus of the destruction is important. As might be expected, this importance, both in respect to expression of already acquired habits and the acquisition of new habits, was found to be in direct proportion to the reduction of tissue mass.

With these broad limitations in mind we may better appreciate Head's statement of the relationship between the locus of nervous-tissue destruction and defective speech. In general, he states the following relationships:

1. A destruction of the lower portion of the precentral and postcentral convolutions and the parts which lie beneath them gives the verbal form of defective speech.
2. A lesion in the upper convolutions of the temporal lobe produces syntactical disorders.

[6]A detailed discussion of test procedures and results with aphasics is contained in Head's two-volume work (26). A study of non-aphasic individuals by means of Head's tests was made by Pearson, Alpers, and Weisenburg (46).

3. A destruction in the region of the supramarginal gyrus causes semantic defects.
4. A lesion situated somewhat more posteriorly than that for semantic defects causes nominal disturbances.

Any attempt to associate anatomical injury and physiological activity must take into consideration the effects of diaschisis. If the lesion is acute and progressive, a small area of destruction can produce profound defects in behavior. If the lesion is of old standing, has had a slow onset, and has occurred in an otherwise healthy brain, a much larger loss of brain substance may cause comparatively superficial defects in behavior. When we consider the fall in neural potency and vitality consequent from it, it is not strange that a lesion in practically any part of the brain (cortical as well as subcortical levels) should directly or indirectly affect such high-grade powers as are effective in speech, reading, and writing. These mental functions, particularly in their higher forms, are dependent upon the optimal efficiency of their neurological substrata, and anything that reduces that efficiency consequently affects them. An acquired disorder of speech is the consequence of a new adjustment of the organism as a whole to its environment. It cannot be interpreted in terms of the malfunctioning of any one specific "center." Organic lesions interrupt the orderly march of events in the central nervous system and call for the establishment of a new dynamic equilibrium to be effective throughout the remaining nervous mass.

Goldstein (23) has called our attention to the fact that in the case of the aphasic a function is adequate or inadequate depending upon the amount of energy available for it. The distribution of energy depends upon the biological significance of a certain function for a given situation. Any brain lesion reduces the amount of available energy. Therefore, functions of little biological significance will be more obviously disturbed in such cases. An example would be that a man of highly emotional make-up would be able to express words in an emotional situation which he would be unable to bring out in simple descriptive language.

The Management of Aphasia.[7] In the reeducation of aphasic patients one must keep in mind that on the basis of the nature of the brain disease, spontaneous improvements, as well as unexpected relapses, sometimes connected with serious general developments in the disease process, may occur. As a general rule, systematic reeducation should not be started before several months have elapsed since the original injury to the brain in order that the processes of restitution of brain function may be given a chance to approach a standstill. During the acute period educational efforts are not of much therapeutic significance. They may, however, be of great value in the study of the psychobiological mechanisms of speech.

The management of aphasics should take into account those emotional

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[7]This section was developed with the assistance of Dr. Eric Lindemann of the Psychopathic Hospital, University of Iowa.

situations and attitudes which are connected with relatively good speech and those which seem to be devoid of speech connections. Generally speaking, it is easier and simpler for the patient to start his learning by repeating or bringing out spontaneously whole sentences rather than by attempting to produce single words or single sounds. In contrast with the usual classroom technique, in teaching aphasics the teacher should begin by varying the situations of the patient rather than by keeping the learning situation constant, in order to bring about the most satisfactory ones in which to learn large groups of speech material.

If the patient has taken recourse to employing telegramatic style or other modifications of ordinary speech, he should be encouraged in following this trend rather than first to relearn the type of motor behavior he has lost for common speech situations. If he is apt to speak better in certain emotional situations, certain drugs or hypnosis may be employed to facilitate the emotional state in which speech is available. In this way a nucleus may be formed from which the patient gradually can broaden the range of available speech performances. With all of this work the patient's personality make-up should be kept constantly in mind. Aside from the significance of certain biological attitudes the emotional content of the subject-matter to which the conversation applies at any given moment is very important. The greatest possible variety of approaches confronting the patient with concrete life-situations will be more successful than efforts at reeducation conducted in the regular school style.

Left-Handedness and Speech Defects[8]

For a long time, there has been a notion, more or less popular, that there is some sort of relationship between left-handedness and speech defects. In the minds of some people this relationship is a very simple one. It may be either that left-handedness itself is an abnormality, one manifestation of which is stuttering, or that stuttering or some other speech disorder may result when a naturally left-handed child is required to give preference to the right hand. However, the relationship, if any, between left-handedness and disorders of speech is undoubtedly a complex one if for no other reason than that both handedness and speech defects are extremely complex reactions of the organism.

Ontogenetically, both speech and the manifestations of one-sidedness are a differentiation from a whole, the whole being large, gross movements involving more or less equally all parts of the organism. At first there are the generalized, largely undifferentiated voco-motor activities of the infant; later there is the speech act imbedded in a whole movement; and,

[8]In this section, I shall not attempt to review and evaluate all of the evidence for and against a possible relationship between left-handedness and speech defect. Rather, I shall try to present sample studies some of which affirm and others of which deny any important relationship between these two factors. The whole question is far from settled. The crucial experiments undoubtedly have not yet been done.

finally, there is a differentiated speech activity of the more mature organism.

Again, at first the young infant moves both legs, both arms, the head, and the body in reaching for an object; later he reaches with either hand, being essentially ambidextrous; and, finally, he uses predominantly the one or the other hand in lead activities. Both of these reaction patterns, speech and one-sidedness, are highly differentiated parts of a total reaction.

The Physical Basis of Handedness. It is difficult to determine definitely whether unilaterality of function is controlled primarily socially or biologically. Coghill's work (8) particularly supports the assumption that development or maturation precedes function. On the other hand, we know that function rounds out the patterns. To me it appears that from a phylogenetic standpoint environmental demands precede structural supplies. However, once a phylum is established, we may view the function as commonly maturing even long before the environment may make demands upon it. Even when environmental demands are realized, maturation limits the extent to which the response can be energized by the stimulus.

A few attempts have been made to understand the possible physical basis of handedness. Jordan (32) held that an asymmetrical blood supply underlies cerebral dominance. The branches of the aorta, particularly in the fetus, are so arranged in most individuals as to supply a relatively larger quantity of blood to the left cerebral hemisphere and the right arm than to the right cerebral hemisphere and the left arm. Further, the left hemisphere receives its blood supply more directly from the heart than does the right. Any considerable disturbance or complete transposition of this general asymmetry might establish the basis for dominance in the right hemisphere, while an alteration in this asymmetrical arrangement to a point producing vascular symmetry might furnish the physical basis for a total lack of dominance. Peterson (48) made a study which bears on Jordan's fundamental thesis. In the rat, before the vascular pattern was laid down in the brain, he found that ligation of a carotid artery and the subsequent depletion in the quantity of blood to the hemisphere formerly supplied by the now ligated carotid did not in the majority of cases cause the hemisphere with the intact carotid supply to become the dominant one. This indicated that the dominance of one hemisphere of the rat's brain as revealed in food reaching was not due to unequal blood supplies coming from the two carotid arteries. There can be little doubt about dominance as revealed by preference in the use of the hands in a food situation being a function of the one or the other of the two cerebral hemispheres. Peterson (47) tested seven rats in a food situation to determine hand preference. They were then subjected to operation in the motor and somesthetic regions of the cerebral cortex of the contralateral hemisphere. As a result of the operations all animals except one transferred either abruptly or gradually to the use of the other (non-dominant) hand. He concluded that extensive destruction of the motor and som-

esthetic fields opposite to the preferred hand will lead to a transfer in handedness.

The physical basis of handedness in human beings is more difficult to study. Smith (53) reported that the posterior end of the left cerebral hemisphere frequently presents features similar to those found in the ape's brain. Such features are rarely found in the right hemisphere, excepting that of a left-handed person, in which case the asymmetry is reversed. This points to a definite specialization of one cerebral hemisphere over the other. Even in the brains of the anthropoid apes this difference is already realized, although not to the same degree as in the human brains. Cohn and Papez (9) reported that in the Cornell collection of ape brains differences of the same nature as are found in human brains were clearly shown in a number of specimens. The orangs appeared to have right-handed brains. These same authors reported a study of 100 human brains in the Cornell collection in regard to the main differences between the two hemispheres that could be made out in the region of the calcarine fissure and the surrounding visuosensory or striate area, such as the form and length of the calcarine fissure and the superficial extent of the calcarine area. The great majority of the cases showed a greater development of the visuosensory cortex in the right cerebral hemisphere. This was taken as definitely associated with the development of handedness. The authors related their findings to those of Dallenbach (11, 12), who showed that position is a condition of clearness and a determinant of attention. For the right-handed person, the position to the left and above has a distinct attentional advantage, while for the left-handed person the position to the right and below has this distinct attentional advantage. It would seem reasonable to assume that, in the case of the right-handed person, more processes leading from the right retinal halves are aroused if the position to the left shows an attentional advantage. Since these processes impinge on the visuosensory cortex of the right hemisphere, we might assume that the right calcarine area would be more developed as a result of this biological necessity. That this is the case has been shown by the study of Cohn and Papez in their study of a large number of brains, the majority of which they reasonably assumed to have come from right-handed persons.

A study that throws light on the phylogenetic evolution of handedness and at the same time seriously questions the theory that handedness is exclusively an outgrowth of social tradition was reported by Tsai and Maurer (69). They found, first, that the great majority of normal rats of both sexes were right-handed, and, secondly, that the percentage of left-handedness was higher in those rats which had been depleted of the vitamin-B complex (through their mother's diet) during the nursing period.

Studies against a Relationship between Left-Handedness and Speech Defect. Two studies, one by Wallin and another by Parson, are frequently mentioned to prove that left-handedness bears very little if any

relation to disorders of speech. Wallin (70), in a questionnaire survey of 89,057 pupils enrolled in the St. Louis schools, showed that the total number of speech defectives of all kinds was 2.8 per cent of the total enrollment. Two and eight-tenths per cent of all the pupils were left-handed; 3.6 per cent of the boys and 2.1 per cent of the girls were left-handed; 4.9 per cent of the speech defectives were left-handed; 9.9 per cent of the speech defectives were or had been left-handed; 2 per cent of all the pupils enrolled were dextro-sinistrals. Nine and four-tenths per cent of the dextro-sinistrals had speech defects and 6.8 per cent of the total number of speech defectives were dextro-sinistrals. Nine and five-tenths per cent of all the stutterers, 6.9 per cent of all the lispers, and 1.7 per cent of all the other types of speech defectives were dextro-sinistrals. Eighty-one and four-tenths per cent of 27 children for whom definite data were supplied began to stutter before they were given any instruction in writing in the schools. Two and five-tenths per cent of all the boys as against 1.5 per cent of all the girls were dextro-sinistrals. However, there was no difference in the prevalence of speech defects among the male and female dextro-sinistrals. Sixteen and nine-tenths per cent of the colored dextro-sinistrals, as against 8.9 per cent of the white dextro-sinistrals, had speech defects. Wallin concludes from these data that the vast majority of left-handed pupils who had been taught to write with the right hand did not develop speech defects.

Parson (45) investigated the total public-school enrollment, 15,000 pupils, in Elizabeth, New Jersey, to find that in the four years that the policy of training all left-handed pupils to write with the right hand had been in effect not a single case of defective speech could be traced to the reversal of manual habit. He believed that whenever stuttering occurred as a result of changing the native handedness of young children it lasted only while the change was being made.

Studies for a Relationship between Left-Handedness and Speech Defects. Ballard (1) made two investigations, one by means of a questionnaire and the other by means of a personal examination of each case. In the first study 13,189 children reported. He found that stuttering was about four times as frequent among dextro-sinistrals (those children who performed with the left hand all the common activities except those that they had been forced to acquire with the right hand) as among the rest of the children. In 944 mentally defective children the number of stutterers among the dextro-sinistrals was about twelve times as great as the number among non-dextro-sinistrals. In the second study, 11,939 children were observed. The percentage of left-handed children was 2.7, 3.5 per cent for the boys and 1.8 per cent for the girls. This agrees with Wallin's finding that there are more left-handed boys than left-handed girls and is suggestive in regard to the fact that male stutterers outnumber female stutterers. In this second study Ballard found further that among the dextro-sinistrals 17 per cent stuttered at present and 25.8

per cent had stuttered. The author's general conclusion is that there is some sort of connection between left-handedness and stuttering.

Nice (40) studied seven ambidextrous children who presented retardation in speech development. Ill health, defects of hearing, malformations of the vocal organs, and backwardness in intellectual development did not appear causally related to the retarded speech in these cases. The only constant phenomenon that appeared was the ambidexterity. These children showed a prolonged state of uncertainty as to which hand should be preferred that was paralleled by a lack of speech development.

In a study of 239 mental defectives with speech defects, Gordon (24) found that 53.9 per cent of them, as compared to 18.2 per cent of the mental defectives in general, were left-handed. Of the 83 stutterers in this group 47 per cent were left-handed; of the other 156 speech defectives, most of whom presented defective articulation, 60 per cent were left-handed. It is interesting to note that Gordon found among mental defectives a much higher percentage of left-handedness than has been found among normals and about 25 per cent more girls than boys who were left-handed.

Quinan (49) made a study of 42 sinistrals and 100 right-handed, right-eyed "pure" dextrals. The sinistrals were divided into three equal groups as follows: Group 1, left-handed, left-eyed, "pure" sinistrals; Group 2, left-handed, right-eyed, "crossed" sinistrals; and Group 3, right-handed, left-eyed, "crossed" sinistrals. Thirty-five and seven-tenths per cent of Group 1, 14.2 per cent of Group 2, 0.0 per cent of Group 3, and 5.0 per cent of the "pure" dextrals gave a history of stuttering in childhood.

In a questionnaire study of handedness, Downey (15) found that sinistral tendencies, either dominance of the left eye or a complete or partial dominance of the left hand in bimanual activities, characterized all but a small percentage of the cases with speech difficulties.

Because the factor of eyedness seemed to be related to, and was far less subject to change than, handedness, Travis (58) made a study of eyedness in stutterers. Mills (38), Parson (45), Travis (58), and Miles (37) have determined that from 13 to 29.3 per cent of normal speakers are left-eyed. Travis found that, of 48 adult stutterers, 45 per cent were left-eyed and 5 per cent were amphiocular (no preference for either eye). Bryngelson reports that of 700 stutterers (463 males, 237 females) 57.3 per cent were left-eyed and 10.3 per cent were amphiocular.

Orton and Travis (44) found that, when the action currents from both forearms were recorded during simultaneous voluntary contraction, they might appear simultaneously in the two arms, but that in by far the greater number of trials those from one arm preceded those from the other. In records of right-handed normal speakers the number of times that the action currents arrived first in the right arm far exceeded such precedence in the left and also far exceeded the incidence of simultaneous leads. In right-handed stutterers the greater number of leads was in the

left arm, and the number of simultaneous leads was much greater than that in normal speakers.

Oates (41) made a study of handedness and eyedness in relation to speech defects in 41,176 school boys. Two per cent of the pure types of handedness and 11.8 per cent of the mixed types of handedness suffered from disorders of speech. Of the pure right-handed boys who had speech defects, 41.4 per cent were left eyed.

Haefner (25) reported that, of 41 children who had been changed from left- to right-handedness, 24 per cent stuttered.

In a detailed laboratory study of the neuromuscular organization of stutterers, Jasper (29) found that unilateral sighting, simultaneous writing, motor leads of bilaterally paired musculatures, mirror drawing, binocular acuity, visual convergence strength, lead eye in binocular convergence and divergence fixations, dominance in the perception of the phi phenomenon, and the relative excitability (chronaxie) of bilaterally paired muscles served to classify quite definitely the stutterers with either the ambidextrous or the left-handed groups of normal speakers.

Travis and Lindsley (67) made an action-current study of 20 pure right-handed and 20 pure left-handed normal speakers and 24 right-handed stutterers. All subjects were adults. They had determined previously (66) that the flexor digitorum sublimis muscles gave, up to a certain amount of contraction, an increase in action-current frequency with an increase in intensity of contraction. Beyond a certain degree of contraction (the critical point) the frequency of the action currents decreased. In the later study these authors found that for all normal speakers except one the critical point was less in the non-dominant than in the dominant arm. For 52 per cent of the stutterers the critical point was less in the right than in the left arm and for 13 per cent of the stutterers the critical point was the same for the two arms. This would mean that for the majority of stutterers either the left arm was dominant or the two arms were of equal dominance.

Of 263 stutterers (largely adults) studied at the University of Iowa, 31.2 per cent of the males and 25.6 per cent of the females were originally left-handed. Three and five-tenths per cent of the males and none of the females were left-handed on coming to the university. Fourteen and six-tenths per cent of the males and 12.5 per cent of the females were ambidextrous on coming to the university. Thirty and four-tenths per cent of the males and 26.3 per cent of the females reported that their original handedness (left) had been changed. Of 1220 University of Iowa freshmen, including stutterers, 2.5 per cent of the men and 2.8 per cent of the women were left-handed on entering the university. Five per cent of the men and 3.3 per cent of the women reported that their original handedness (left) had been changed.

As I see it, the question of a relationship between left-handedness and disorders of speech is far from being definitely answered in either the affirmative or the negative. The most careful laboratory studies show

a sinistral or an ambilateral nature to be characteristic of the bilateral neural organization of most stutterers. However, all studies, including the laboratory ones, demonstrate a significant minority of stutterers to be strictly unilateral (dextral) in neuromuscular organization. Further, they show that a certain number of normal speakers express definite sinistrality or ambilaterality. The relationship between sinistrality and ambilaterality and speech disorders is undoubtedly not a simple causal one. Much further careful work is necessary before we can say definitely just what the relationship, if any, is.

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CHAPTER 17

EIDETIC IMAGERY

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Since eidetic phenomena in children have been subjected to an experimental analysis in hundreds of investigations, it seems desirable to examine the material at hand in order to determine some of the facts arrived at. This is not an easy task since many investigators have presented their results in a way which makes it almost impossible to separate fact and theory. It cannot be said that there are many points concerning which a general agreement has been reached; still it is at last conceded that eidetic images (EI) exist. As a matter of fact, the chief value of the extensive work carried on during the last decade must be sought in the formulation of a large number of special hypotheses which can be put to an experimental test. Unfortunately, very often too much emphasis has been laid on the importance of the data for psychological theory, and, even, for education. Especially the Marburg publications, although always extremely stimulating, suffer from a certain hypertrophy in theoretical matters. It is chiefly due to this hypertrophy that there is no dearth of experimental problems at the present time.

E. R. Jaensch in Marburg must be credited with having been the first one systematically to attack the problem of eidetic imagery in children. EI or, to use the German equivalent, *Anschauungsbilder* are subjective visual, auditory, etc., phenomena which assume a perceptual character. An eidetic individual, after having been asked to look attentively at an object, is able, with eyes open or closed, to "see" this object again. This is possible either immediately or after a certain lapse of time, even after the passage of several years. These eidetic phenomena, as "images of hallucinatory clearness," are seen "im buchstäblichen Sinne"; they are seen in the sense that after-images are seen. Although the stimulus object may be reproduced with almost photographic fidelity, EI as a rule differ from the original stimulus object with respect to color, form, and the number of details. They differ from hallucinations in that the eidetic individual does not believe in the objective reality of the phenomena but recognizes their subjective character; they differ from memory-images in that the phenomena are really seen.

These EI, it is pointed out, are not of pathological nature but must be considered as phenomena in "normal and healthy" persons. We may add that Urbantschitsch (39), to whom we owe the first experimental investigation of EI, made the distinction between the "ordinary visual memory-image," which is merely imagined, and the "perceptual memory-

image," the *Anschauungsbild,* which is "seen." These remarks may suffice for characterizing EI in a preliminary way.

It is apparent that EI are more or less related to phenomena such as after-images, memory-images, projected memory-images (Martin), memory-after-images (Fechner), subjective visual sensations (G. H. Meyer), pseudo-memory-images (Grünbaum), illusions, hallucinations, pseudohallucinations, re-perceptions (Ebbecke), phantastic visual phenomena (J. Müller), *Sinnesgedächtnis,* hypnagogic images, synesthesia, and subjective visual phenomena produced by hypnotic methods or by drugs; but it is at present often extremely difficult to say in what way some of these phenomena are different from EI. Obviously, many of the foregoing phenomena are no better defined than EI, and in only some instances, as, e.g., in the case of after-images, has the application of experimental methods resulted in a body of well-established facts.

Methods of Investigation

Since EI are phenomena appearing in the *Wahrnehmungsraum,* it follows that the methods developed in the field of perception may be used for determining the behavior of EI in perceived space. So far as visual perception is concerned, we are able, on the basis of our knowledge of the stimulus situation, to predict within certain limits the perceptual response. This knowledge has been utilized by the Marburg school in developing methods for the study of the EI. Most investigators have modified these methods but slightly in order to obtain comparable data. This is not meant to imply that all investigators have been satisfied with a mere application of these methods. To determine the presence or absence of EI in an individual and to ascertain the kind of EI he possesses has been, for most students, merely the point of departure for further research. In the following we shall shortly describe the methods worked out by Jaensch in the psychological laboratory of the University of Marburg (13, 17). It seems inadvisable to present and, at the same time, critically to evaluate these test procedures. A presentation of the methods as given below will serve, on the one hand, to define more clearly the nature of the phenomena, and, on the other hand, it will bring to light some of the assumptions made by the Marburg school with respect to the behavior of the EI.

Test Material. In most tests the child is seated before the narrow side of a table with his back towards the window, and a projection screen (40 by 60 cm.) covered with dark gray paper is placed at a distance of 50 cm. from the eyes. This screen can be easily moved backward and forward. Markings on the table indicate the various distances between the screen and the eyes of the subject. In case measurements of the size of the EI are to be made, the position of the head of the subject is fastened. The stimulus object to be attended to by the child is first exposed on the screen and, then, after the stimulus object has been removed from sight, the resulting phenomenon is observed on the gray background. W. Jaensch

considers "medium daylight" as the most desirable illumination in the experimental room. In some cases a constant artificial illumination is used, but "to make exact measurements for determining the brightness in the experimental room is not necessary since the character of the images is within wide limits not influenced by brightness changes." Stimulus objects like the following are employed: 5-cm. squares consisting of cardboard and covered with colored paper (Hering's papers); pictures of animals, houses, and trees, etc., cut from a child's picture book; *Münchener Bilderbogen,* or silhouettes and pictures rich in detail and color. In general, the size of the stimulus pictures does not exceed 9 by 12 cm. The scenes represented by the pictures should appeal to the interests of children. Finally, toys or similar tri-dimensional objects (height up to 8 cm.) are recommended. The size of the phenomena is measured by means of a compass the points of which must be clearly visible at the various distances used. The investigation of the EI is preceded by an examination of the after-images (AI) of the child.

Examination of the AI. First, the duration of the AI is determined under specified conditions. A 5-cm. square with a black fixation point in the center is presented at the level of the eyes for 15 seconds. After the removal of the colored square the child is instructed to fixate the place where the stimulus object was presented and to report, without permitting any eye-movements, the time of appearance or disappearance of the AI, its color, and the definition of its contours. The AI may appear immediately or a few seconds after the end of the exposure. The color may be the same as, or the complementary of, that of the stimulus object, or it may even be some other color. The AI may be seen continuously before it disappears, or it may come and go intermittently. It is stated that, on the average, under the above conditions an intermittent AI may persist in the case of eidetic individuals for about 40 seconds. W. Jaensch admits, however, that even for non-eidetic subjects the values vary considerably. Often in the case of non-eidetics the presentation of the stimulus is followed by an AI with ill-defined contours, lasting only a few seconds. Although no norms are presented, it is maintained that the AI of eidetic persons are only infrequently of short duration. In strong eidetic cases the AI may, under the above conditions, last for 400 seconds or longer. It is assumed that not only the duration (total duration up to the time of disappearance, as well as the duration computed by adding the different phases of the intermittent AI) is of importance, but also the time during which the AI has well-defined contours and remains fairly constant in appearance.

Since EI are supposed to differ from AI with respect to Emmert's law (23, p. 186), the size of the AI is measured at various distances of the projection screen: 100 cm., 150 cm., 20 cm., and 35 cm. In case the duration of the AI is not sufficient for undertaking these measurements successively, or the contours are not clearly enough defined, it becomes necessary to expose the stimulus object again before measuring the AI in

a new position of the projection screen. The AI of eidetic individuals are said to differ considerably with respect to Emmert's law, especially at distances greater than 100 cm. or less than 50 cm.: 35 or 20 cm. An examination of AI may lead to results indicative of a "latent" eidetic disposition, although a careful examination may not reveal the actual presence of EI. Such a "latent" eidetic disposition is inferred (*a*) from deviations from Emmert's law; (*b*) from the appearance of certain details in the AI of a colored square, such as, e.g., the fixation point; (*c*) from the fact that the AI does not appear immediately after the removal of the stimulus object (period of latency); and (*d*) from the observation that the AI differs from the size of the stimulus object even at the original distance of presentation. The examination of AI of uniformly colored squares is followed by an examination of AI of more "complicated" objects, such as silhouettes. With the relatively short exposure time of 15 seconds, some individuals do not get an AI at all, whereas others see an AI with many or all details, sometimes even in the original color. In short, such persons do not see a pure AI, but, according to Jaensch, an AI which, although appearing after fixation, has many of the characteristics of the EI.

Finally, the "density" of the AI is tested. The AI, e.g., of a red 5-cm. square, is projected on an optically inhomogeneous background, such as one consisting of well-defined black and white vertical stripes. The question is whether or not these stripes can be seen through the AI. Through a very "dense" AI the ground cannot be seen.

Examination of the EI. The examination of the AI precedes the eidetic tests because it is the most effective way of bringing home to the subject what is meant by "seeing." It is suggested, however, that during the day of the eidetic examination no detailed investigation of the AI be made. Nevertheless, in a few experiments the statements of the subject concerning color and appearance of the AI may be checked.

In testing the subject for EI, the stimulus object is not fixated but looked at "naturally." This means that in most cases eye-movements occur. When using colored squares as stimuli the investigation proceeds in about the same way as in the AI-experiments. The square is viewed "naturally" for 10 seconds. In determining duration, size, etc., of the EI, special attention is paid to the contours. If, under the above conditions of arousal, an image with well-defined, sharp contours appears, this fact is taken to mean a "weak eidetic disposition." Positive EI are supposed to indicate a higher degree of the eidetic disposition than negative EI. The experiments with uniformly colored squares are followed by tests with more interesting objects. The fact that the EI aroused by presenting squares are complementary and only faintly colored does not imply that very detailed EI of complicated stimulus objects are not producible. As such complicated objects, pictures of houses, animals, and interesting scenes are suggested. The pictures must be of a kind to attract the attention of the child, and it is necessary to have a large supply of material

at hand, for EI often appear only after the presentation of a picture or an object of special interest. In arousing EI a certain process of "selection" is operative. Jaensch reports that some subjects cannot revive unpleasant and ugly objects eidetically, whereas others have the same difficulty with respect to geometric figures (12). If EI cannot be aroused at all, it is advisable to darken the projection screen or to ask the subject to close his eyes, since such procedures may sometimes lead to eidetic reproduction. The size of the stimulus objects is in general the same as in the AI-investigation. In connection with these EI-tests the experimenter may inquire whether EI appear spontaneously in emotionally toned situations.

Using the previously mentioned stimulus material, EI are tested with respect to duration, "density," and Emmert's law. In the case of tridimensional EI, the subject may see positively colored EI having depth of perspective, in spite of the fact that the EI of two-dimensional objects for this subject are negatively colored. On the basis of the different EI-tests the "degree" of the eidetic disposition is determined, the subjects being grouped on the basis of the distinctness and the number of details seen in the EI. Finally, the EI are tested for "flexibility." Alterations in simple or detailed EI often occur without being intended by the subject, and frequently such changes can be elicited by extraneous disturbing stimuli. For instance, a sudden whistle may cause a red square to turn into a locomotive. In most cases alterations of this kind are not meaningless, although in some instances they are confined to changes in the color and the position of certain figures. Whether changes can be intentionally induced or EI can be made to appear or disappear "at will" is also tested with simple and complicated stimulus objects. A subject, seeing a house in the EI, may be requested to see a train passing by or a car stopping before the house. In other tests the EI is projected on variously shaped projection screens to determine the influence of the different shapes on the characteristics of the EI. There follows an examination for "fluxion," i.e., for the appearance of certain movement phenomena, resulting from the successive exposures of similarly shaped objects, such as different leaves from a tree.

Control Experiments. On account of the important rôle the statements of the subject play in EI-investigations, considerable attention must be paid to the question of objective controls. To begin with, the following facts are pertinent. Often an exact eidetic reproduction of very complicated objects is observed after short periods of exposure. Even quite inessential details are thus faithfully reproduced. Furthermore, the attitude of the subject in attending to and describing his EI is the same as towards real objects: He looks attentively at the projection screen; he performs eye-movements while describing various details of the EI; he moves the projection screen in order "to get a better look" at some of the details, and, frequently, marked expressive movements are observed in excitable children. A further check on the statement that the EI are really seen is the successive appearance of the various parts of the EI. Sometimes questions regarding certain details of the picture cannot be answered by

the subject because these details are not remembered, and yet, after a while, these features appear in the EI; they become more and more distinct, and the subject is finally able to describe them correctly. The letters of a familiar word may appear in irregular order in a manner which is different from the normal spelling. The most important controls, however, depend on the fact that the EI follow "laws" similar to those operative in the field of visual perception. Children, as well as many adults, are not familiar with these laws established in sensory physiology and in psychology of perception. Such persons do not, e.g., know the exact complementary colors on different backgrounds; at least, they do not know the deviations from the complementary colors as determined by Broer (3), the Purkinje phenomenon as found in AI and EI, the Hering-Hillebrand deviation from the horopter, or a large number of other phenomena which are evidenced by the reports of the subjects, and which are utilized in checking up on the truth of their statements.

Evaluation of Methods

We have sketched in a very general way the methods used by the Marburg school in investigating the EI. For a closer study, especially of the question of objective controls, we must refer to the Marburg publications (cf. *Zsch. f. Psychol.,* vols. 84-126). It is not possible here to evaluate in detail the various methods suggested. However, some of the underlying assumptions of the whole test program must be considered.

To begin with, it is assumed that an experimental investigation of such intricate visual phenomena as EI is possible. This assumption, it seems to us, is entirely justified, since the experiments uncover certain consistencies in the behavior of the EI. It must be recalled that no serious objections have ever been raised to AI-experiments or to experiments in psychophysics merely on the ground that the subject is called upon to report on visual phenomena. Since in psychophysical experiments, for example, a remarkable consistency in the responses of different subjects was found, no inquiry was made into the nature of the subjective experiences of the subject, e.g., into the question whether the remarkable consistency in "brighter-than" judgments was based on phenomena which were "sensed" or "imagined," or on the borderline "between sensation and imagination." There is a very real question, when employing visual stimuli in psychophysical experiments, as to why we should assume that the subject actually "sees" the stimuli and does not "imagine" them. The same difficulties arise with respect to the "subjective" character of AI. As experimenters, we do not worry about these difficulties. While a thorough analysis would point to such factors as "attitude" and "set" as decisive for the "objectivity" or "subjectivity" of certain phenomena, we are rightly satisfied with determining consistencies. As fas as eidetic research goes, one certainly cannot expect more than this at the start. There is no question that eidetic phenomena may be successfully investigated by means of experimental methods. On the other hand, it is true

that the irregularities in the behavior of certain EI, and their "apsychonomic" character, as determined by Urbantschitsch, appeared to be so great that eidetic research was discontinued for about a decade, and that Jaensch was led to exclude these "apsychonomic" cases from his investigation. The fact that the EI of certain individuals apparently fail to obey definite laws should be but another reason for investigating these persons as thoroughly as possible. The exclusion of these cases, it seems to us, has led to a one-sided view of the nature of eidetic phenomena.

We must consider the further assumption of the Marburg school that reliable results may be obtained from an investigation of children. On the basis of our studies we contend that Jaensch is right in assuming that in eidetic studies children may be used as profitably as adults if proper controls are employed. To maintain that the statements of children are, in every situation and with respect to every object, always more inaccurate and unreliable than those of adults is an assertion demanding proof. The value of eidetic experiments depends more on the kind of controls than on the kind of subjects used. That even preschool children are capable of highly accurate observations of AI has, for example, been shown by Révész (34).

The Marburg school tacitly assumes that the above test procedure permits of determining whether or not a child is eidetic. But, to find that the phenomena under investigation display some consistency is one thing; to call these phenomena "eidetic," as distinct from AI, memory-images (MI), and other phenomena, is another thing. It is at this point where a large number of assumptions made by the Marburg investigators should be subjected to a critical analysis. Unquestionably, many of the assumptions concerning the size, the duration, the clearness—in short, the general behavior of AI and MI—are entirely lacking in foundation, whereas still others are based on too small a number of subjects and on contradictory introspective reports. To be sure, there are phenomena, elicited under the above experimental conditions, which are unmistakenly different from AI and MI and, therefore, may be justly described as EI. But we cannot overlook other phenomena which do not permit of such a clear-cut differentiation. Their behavior is very similar to that of AI or MI. In interpreting this behavior, we soon discover that many of the characteristics of the AI and the MI are as yet imperfectly known and, therefore, cannot be utilized in differentiating the AI, the EI, and the MI. The assumption of the Marburg school that there is a sufficiently large number of criteria at hand for differentiating the AI and the MI from the EI is merely an assertion and not a fact.

It cannot be too strongly emphasized that, even if Jaensch's methods were "fool-proof," research on EI would face exceedingly great difficulties. It quickly becomes apparent that many of the phenomena safely classed as neither AI nor MI have characteristics very difficult to study by experimental methods. Some of the criteria considered crucial in identifying EI are theoretically simple enough, but in actual experimenta-

tion, employing a large assortment of stimuli under different conditions, they are often extremely troublesome to apply. Certain color phenomena, for instance, may be ascribed to the EI, while they certainly constitute well-known features in the AI of complicated objects. What the experimenter needs is a thorough familiarity with the facts pertaining to contrast, adaptation, entoptic effects, the MI, the AI, and related phenomena, as determined in the researches carried on during the last decades. A study of physiological optics is a prerequisite.

The "Unitary Type"

There is no doubt that in general EI disappear at the time of puberty and that eidetic cases are rather rare among adults. In spite of the greater frequency of EI in children and young people, we are not convinced that eidetic imagery is of such fundamental importance in the ontogenetic development of mental life as the Marburg school assumes. The theory of the "unitary type" (29) holds that EI represent the ontogenetic source of perception and that a "latent" or "overt" eidetic period in childhood must be considered a "normal" phase. Even Jaensch admits that there are children in whom the most rigid methods of examination cannot reveal any trace of an eidetic disposition. In such cases, the ancestors may, nevertheless, have been eidetic. Genetically, the point of departure is the undifferentiated unity of the EI which, in the course of ontogenetic development, differentiates itself into various phenomena. As long as a child belongs to the unitary type his AI, EI, and MI show the same or a very similar behavior under experimental conditions. When projected on a screen, when examined with reference to "spatial displacements," etc., the AI, EI, and MI of the unitary type hardly differ. Negative AI cannot be produced even after long periods of fixation; MI pass immediately over into EI. The objects represented in EI closely resemble, and are even mistaken for, objects presented objectively. With increasing age, then, the unitary phase splits up, and AI, EI, MI, and perceptions become clearly distinguishable.

In testing the hypothesis of a unitary type, research on very young children becomes a necessity. From the conception of an undifferentiated unity it necessarily follows that the "acme" of the eidetic disposition is to be found in early childhood. Yet only infrequently have the Marburg investigators examined children below the age of ten years. Some results, however, are available bearing on the problem of unitary cases.

When employing special methods for examining four-to-six-year-old children for AI, we found that at this age negative AI exist. Kiesow (19, 20), on the basis of a similar investigation in Italy, maintains that the absence of negative AI in four-to-six-year-old children is the exception rather than the rule. Recently, Roessler (35) tried to clear up the whole problem of a unitary type by an experimental study of 726 six-to-ten-year-old children, examining 421 of these children individually. Forty per cent of the group of 726 were found to be eidetic. Comparing different age

levels, the highest percentages of eidetic cases and the highest "degrees" of eidetic imagery were found in the six-year-old group. In other words, the youngest group investigated represented the "acme" of the eidetic disposition. In fact, the greatest number of eidetic phenomena were observed in the first weeks of school life. Roessler interprets his results as lending support to Jaensch's view that the EI is the primordial form of our perceptual and imaginal responses.

It is to be conceded that Roessler has been well aware of the sources of error involved in investigations of young children. Even so, it seems desirable to check his findings on children of the same age in different localities and in different school systems. If further research shows that EI are most frequently found at the age of six or in children of preschool age it does not necessarily establish the ontogenetic importance of a unitary type. If it can be shown that at an early age perceptions and perceptual MI, i.e., EI, resemble each other very closely, whereas at a more advanced age the resemblances are very slight or entirely lacking, it does not thereby demand a genetic interpretation with an undue emphasis on the rôle of EI. Jaensch's recent attempt to show that EI and perceptions are closely related in many ways seems to be of greater promise than his hypothesis of an undifferentiated unity of the AI, the EI, and the MI. It must be pointed out that there exists a great deal of confusion in the recent Marburg publications in that *genetically* the EI is not considered quite as important as heretofore but *descriptively* it still occupies a position intermediate between the AI and the MI.

Relation of the EI to the AI and the MI

In numerous researches Jaensch and his collaborators tried to show that the AI, the EI, and the MI form three "levels of memory," the lowest of which is the AI and the highest of which is the MI. Busse (4) examined the behavior of AI, EI, and MI with respect to localization, color, clearness, phenomenal appearance, "weight," the degree of "flexibility," the degree of "coherence," the conditions of arousal and disappearance, and the relation to distracting stimuli, etc., and reached the conclusion that the EI assumes a position intermediate between the AI and the MI. Gottheil (8), in a study of non-eidetic individuals, examined AI and MI with respect to size, phenomenal appearance, color mixture, and the influence of an inhomogeneous background or of changes in the position of the head on the localization of the phenomena. She found that the AI and MI in eighteen non-eidetic individuals, aged twelve to seventeen and a half years, were indicators of "latent" eidetic imagery. The measurements of the size of AI in these persons did not give the values to be expected on the basis of Emmert's law, while this law was found to hold in eighteen non-eidetic adults, aged twenty-two to twenty-five years. Schmülling (37), examining AI under intermittent retinal stimulation, concluded that AI observed in such a way assume characteristics similar to those of EI. The method of intermittent retinal stimulation is sug-

gested as suitable for the detection of a "latent" eidetic disposition. Gösser (7) used twenty-one eidetic individuals in studying the behavior of AI, EI, and MI when observed with open eyes under different conditions: on a homogeneous background, on a background tilted to the right or left, and on a curved surface. The conclusion is reached that AI, EI, and MI have different degrees of "coherence" with "perceptual data." The coherence with external objects was found to be least pronounced in MI and most pronounced in AI, while the EI, again, assumed an intermediate position.

In the foregoing studies, as well as in a number of closely related researches, the experiments led to the formulation of different "laws." An analysis of these studies, it seems to us, warrants the conclusion that these laws—in fact, the whole theory of memory-levels—is based on rather scanty experimental evidence. It is difficult to see how Jaensch's quantitative formulations concerning the position of the EI between the AI and the MI are justified, in view of the small number of subjects used and the many ambiguities inherent in his experimental methods. In most cases we do not learn anything about the variability of the values presented for a given memory-level. A seemingly simple test, such as the determination of the size of the AI, involves, as Koffka (28) and Kiesow (21) have shown, considerable difficulties even with non-eidetic adults as subjects. The Marburg investigators are neither sufficiently aware of the magnitude of the variations from the central tendency nor of the factors responsible for variability in the size of the AI. It seems that there is not even a clear conception of the variations in the size of the AI in non-eidetic adults when measured at a distance equal to the distance of exposure. Even granting that the difficulties encountered in AI-experiments can be overcome, it is hard to understand how MI-experiments can be successfully carried on with children. To ask a person to project an MI on a screen and then to measure a phenomenon that cannot be seen seems a somewhat questionable procedure, and especially so with children. Still, many Marburg investigators made "exact" measurements of the size of such MI. Kobüsch (16, p. 253) was able to determine the exact size of MI in non-eidetic individuals with strong or weak visual imagery. Giersch (32, p. 162) instructed twenty-nine children, aged nine to eleven years, to produce AI and EI, as well as MI, of a red square and the picture of a house. She made exact measurements of the size of these various phenomena. How such measurements can form a secure basis for deriving laws is difficult to conceive. In our own investigations no attempt was made to determine the size of MI. The investigation of MI was also excluded from the test program in the studies of Zeman (41), Fischer and Hirschberg (6), Zillig (42), and Liefmann (32). Finally, it must be recalled that in relating EI to AI and MI the Marburg investigators did not include in their study the EI with "irregular" or "unpredictable" behavior. Only EI with characteristics in some way similar to those of AI and MI

were considered. That EI of this kind exist may be conceded on the basis of our own studies; but this does not justify the exclusion of the irregular EI.

The question may be raised, then, as to the scientific importance of an attempt to relate the EI to the AI and the MI. In evaluating this phase of eidetic research it seems to us (*a*) that many hitherto unknown characteristics of AI have been discovered and that many of the experimental problems involved have been formulated; (*b*) that there are EI whose behavior is regular and predictable; (*c*) that the psychology of perception will undoubtedly profit by investigating problems of adaptation, contrast, "transformation" (influence of illumination), etc., in eidetic or non-eidetic children. The researches of E. R. Jaensch, Kroh, Herwig (11), Feyerabend (5), Walker (40), and others have undoubtedly thrown new light on important problems of color vision.

Degree of Eidetic Imagery

There seems to be general agreement that EI range from "weak" to "strong," in other words, that there are "degrees" of eidetic imagery. Scales have been constructed for indicating these differences. In Table 1 some of the scales of different investigators are represented.

With respect to the preceding scales it must be remembered that EI are elicited without fixation of the stimulus object. W. Jaensch, who maintains that in certain individuals EI may be aroused only after fixation, has also distinguished various "degrees" of eidetic imagery in fixation tests (17). The question of the degree of eidetic imagery is important, especially in view of the fact that the percentages indicating the frequency of eidetic imagery in different districts are very often computed in terms of unlike scales. In analyzing the results on the frequency of eidetic imagery it becomes necessary to keep in mind the way "latent" cases are treated, the number and kind of stimulus objects used, the nature of the ground on which the EI have been projected, etc. By including latent cases, in Jaensch's sense, and also individuals who can see EI only with closed eyes, one may easily arrive at very high percentages of eidetic individuals in a given district. As regards the criteria for differentiating various degrees of eidetic imagery, it seems advisable not to rely on color but, as Roessler does, chiefly on richness in details. To us it seems best to exclude "latent" eidetic imagery altogether in determining the degree of eidetic imagery. We cannot even follow the suggestion of Liefmann and Roessler in speaking of latent eidetic imagery in case the AI differ in several respects, size, color, and duration, from "normal" AI. The facts on which the diagnosis of "latent" eidetic imagery has been based certainly merit careful consideration and further research, but at the present time the diagnosis itself seems superfluous. We are rather inclined to accept Kiesow's view that the term "eidetic" should be employed only for phenomena of the type described by Urbantschitsch.

TABLE 1

SCALES FOR INDICATING DEGREES OF EIDETIC IMAGERY

Jaensch (17)	Fischer and Hirschberg (6)	Zeman (41)	Roessler (35)
V. Extremely distinct and clear EI, permitting all-*around* experimentation.	4. Extremely distinct EI of the whole stimulus object; almost all details are visible.	A. Distinct EI with all or almost all details of the stimulus object.	A. Very distinct EI of complicated stimulus objects with all or almost all details.
IV. Clear and complete EI of complicated objects may be obtained.	3. The EI shows one or several details of the stimulus or of parts of the stimulus.	B. Distinct EI of certain parts or figures of a complicated stimulus object.	B. Very distinct *partial* EI of complicated stimulus objects with all or almost all details.
III. Weak or fairly distinct EI of simple objects, even without fixation; in case of complicated objects, certain details, either after presenting a stimulus or spontaneously, appear.	2. EI of homogeneous coloration without any details of the stimulus or parts of a simple or complicated stimulus.	C. Even in employing complicated pictures as stimuli, nothing but distinctly colored areas or clearly defined contours of the picture appear.	C. EI of medium clearness or faint EI; contours, colored spots, or some interesting details.
II. Fixation is no longer required in all cases; some extremely weak EI may appear after the presentation of simple objects (uniformly colored squares); disturbing stimuli cause deviations from Emmert's law and changes in shape.			
I. EI not directly producible; *eidetic* disposition inferred from the behavior of AI (deviations from Emmert's law, etc.).	1. Manifest EI are not found; the *eidetic disposition* manifests itself in deviations from "normal" AI.		

Frequency of Eidetic Imagery

On account of the difficulties just outlined, the figures on the frequency of eidetic imagery in different districts are not always strictly comparable. These figures range from 0 to 100 per cent in different localities. But, even if one takes into account the differences in experimental technique, and considers also the point that group investigations are only of slight value, the fact remains that different geographic districts differ widely in respect to the frequency of eidetic imagery. This fact seems to stand out in the German researches as well as in our own studies carried on in different regions of the United States. These local differences have as yet not been satisfactorily explained. Kroh (31) believes that both geophysical and hereditary factors must be considered. He contends that the differences in the frequency of eidetic imagery is geologically uniform regions may be explained by the fact that the drinking water is secured from geologically different regions or that parts of the population have migrated from other districts.

While there seems to be agreement that EI disappear, as a rule, during or after puberty, the period of the "acme" of eidetic imagery, the age at which EI are mostly frequently found, and found in the highest "degree," is not yet agreed upon. Most often the age of twelve years has been suggested; but, after Roessler's investigation, six years or below promises to be more correct. There are some results indicating differences between boys and girls in the frequency of eidetic imagery at different age levels. But, on the whole, the evidence on sex differences seems to be conflicting.

Types of EI

EI, as observed under experimental conditions, differ so markedly in their behavior that from the very beginning two types of EI have been distinguished by the Marburg school. In the case of the *first* type, the EI is often nothing but a visualized idea projected into perceived space; whatever the subject is thinking about is visualized with sensory vividness. He can, without any effort, produce EI and, at pleasure, banish them; he can do this without a preceding presentation of a stimulus; he can change the shape, the color, the position, etc., of the EI in case such changes are meaningful, and he considers the spontaneously arising EI as perfectly "normal" phenomena. His EI are in most cases positive, showing the color of the stimulus object; they are rich in detail and, on the whole, easily influenced; their size, under various conditions, is about the same as that of MI; the EI may last indefinitely, the duration depending on the subject's "will;" "fluxion" is very pronounced.

In the *second* type, EI are more like AI in many respects; the subject is, in most cases, not in the position to see EI at will; the EI very often do not disappear, in spite of the subject's trying to banish them; the form, the color, and other characteristics of the EI are not easily changed, and any changes initiated by the subject appear strenuous and proceed very

slowly; spontaneous EI, if they ever occur, are viewed as unpleasant; the EI show in most cases the complementary color; Emmert's law holds in most cases; the duration of the phenomena is independent of the intention of the subject; "fluxion" is only infrequently observed.

The difference between these two types of EI propounded by Jaensch is essentially a difference between fluctuating and non-fluctuating EI. The first of these types is called the B-type, referring to Basedow's syndrome; the second one, the T-type, referring to tetany. Do the data, it may be asked, justify a distinction between two main types of EI? We have no doubt that any experimenter studying eidetic imagery will find fluctuating as well as non-fluctuating EI, and the research published so far supports this contention. Most investigators have described EI both of the B- and the T-type. Still, there is a difference between finding individuals whose EI have either the characteristics ascribed to the B- or to the T-type and the assertion that fluctuation is the chief criterion for *all* forms of EI. Moreover, in employing "fluctuation" or "lability" as a criterion, pure types are the exception rather than the rule and most eidetic individuals belong to a "mixed" type, a BT- or a TB-combination. It is evident that the characteristics of the EI, as found by experimenting on large groups, permit not only of classifying EI into fluctuating and non-fluctuating EI but of many other classifications. To be sure, such considerations do not do justice to Jaensch's typology. For Jaensch, the distinction between a B- and a T-type means more than a distinction drawn on the phenomenological level. It means that these types are etiologically different, that they represent differences between complex behavior units comprising disparate variables. The difference in EI-behavior indicates a difference between constitutional types or general biotypes. The differences between the EI of the B- and the T-type are correlated with differences in the behavior of the AI and the MI, with differences in intellectual and emotional reactivity, and with somatic differences.

Jaensch's attempt to establish general biotypes must be considered highly significant for the experimental psychology of personality; still, it must be borne in mind that it is merely an attempt. The controversies in the literature show that these types are far from being generally accepted and that many points must be settled before they can rest on a firm foundation.

As regards the psychological phase of this research, it seems advisable not to "typify" prematurely, but to determine more carefully the great differences in form and content of the EI of different persons. Some of these differences will become apparent in considering some of the outstanding characteristics of the EI. Unfortunately, in studying the literature on eidetic phenomena, the reader cannot form a precise idea of the varieties of EI-behavior, owing to the fact that in most instances complete protocols of the subject's reactions are not included.

Some Characteristics of the EI

It happens only exceptionally that all details of the stimulus object are correctly reproduced in the EI. There seems to be a continuum from a "blurred shadow" to almost photographic fidelity. Although such fidelity is very striking, it is not the exact eidetic reproduction but the difference between object and EI which is of special interest for psychological analysis. The minute reproduction of meaningless details has conceivably impressed most investigators. To quote Allport (1):

> "The precise number of buttons on a pedestrian's jacket, the letters composing a word in a *foreign* language on a poster in the background, the length and direction of the lines of shading in a stretch of roadway, the number of whiskers on a cat's lip—such are the amazing details, fundamentally unrelated to any 'nucleus' in the original presentation, which the true *Eidetiker* is able without effort to report."

It seems amazing that an Italian child, without special effort, should reproduce Hebrew words or symbols taken from the Phoenician alphabet (21). The presentation of a picture for 30 to 60 seconds may be sufficient for obtaining very accurate EI after some months or even a year. The ability to produce faithful EI of fairly complicated objects is also found in children of low intelligence and in *idiots savants*.

As emphasized by different investigators, visual memory and eidetic memory are largely independent of each other. Objects, forms, colors, etc., well remembered by the subject, are not necessarily seen in the EI. The intention to see them in the EI may be entirely ineffective. On the other hand, some of the objects appearing in the EI are correctly described although they are not remembered by the subject. If the stimulus object is presented for a second time, the EI is not always more complete and more distinct than after the first exposure. Often the EI does not appear at all after the second presentation. We found some cases in which successive exposures resulted in a "building-up" of the EI; after every new presentation of the object it became more distinct and complete. As a rule, the EI, after the stimulus object has been presented for the first time, appears gradually. The successive appearance of the various parts of the EI is watched with a great deal of interest by some subjects, while others "try" to make certain details appear. In some instances the details of an EI appear simultaneously "like a flash."

The difference between stimulus object and EI, with respect to color, size, number of details, etc., and the changes appearing in the EI while observed, have been carefully studied by Urbantschitsch, Jaensch, and others. Urbantschitsch investigated at great length especially the changes brought about by disturbing (visual, auditory, thermal, etc.) stimuli. In our own investigations special attention was paid to the disappearance of the various parts of the EI, to the final period of "fading away" which frequently represents a reversed "building-up" process.

In considering the appearance and disappearance of the parts of an EI, it becomes apparent that these parts, although often relatively meaningless—feet without the legs, eyes without the head—are optically, nevertheless, "wholes" or "sub-wholes." Still, in some EI fragments, such as parts of a letter, e.g., half of a *u* or the dot of the *i*, or parts of a figure, e.g., the upper part of a *7* or the lower half of an *8*, may appear. In one of our experiments the word RICHMOND, appearing in a picture with many details (time of exposure: 60 sec.), was, although not remembered by the subject, eidetically reproduced in the following manner:

```
     O
RI   O
RIC  O
RICH O
RIC  O
RICH O
```

The various stages in reproducing this word were separated by intervals as long as a minute. The position of the M was indicated by "empty space," the C was referred to by a movement of the index finger: "There is a curve like this." Recently we have called attention to the possible theoretical significance of these "fragmentary" eidetic images (27).

The elements in the EI, no matter whether we are dealing with fragments of the above kind or with characteristic parts of the stimulus object, with wholes or with sub-wholes of some kind, can be *influenced* in many ways. It is this fact which has led to the development of a number of experimental procedures in eidetic research. It is not possible here to discuss these techniques at length; however, some of the fundamental problems involved should be pointed out.

We know that EI may arise spontaneously; yet most of the facts in the field of eidetic imagery are experimentally determined. These experiments are possible only because of a certain "attitude" which the subject assumes in following verbal instructions or the suggestions inherent in the experimental procedure. In interpreting data, we should not lose sight of the importance of this "attitude," i.e., *intention to see.* It so happens that the phenomena appearing after the presentation of a stimulus object, while *not intentionally* influenced by the subject, may undergo various changes, such as rotational displacements; translocation of colors, shapes, and movements; changes in size and color; changes from "dots" to meaningful objects and vice versa. Experiments show, also, that in some instances the "concentration" of the subject, and his intentionally focusing his attention on certain parts of the EI may be effective. Missing elements may suddenly or gradually appear; elements may appear showing characteristics not found in exactly the same way in the stimulus object; missing elements may appear and cause the disappearance of elements present in the EI; the missing elements may not appear, but spatial displacements or rotations in the EI may take place. Effects similar to those brought about

by "concentration of attention" also very often follow the sudden application of disturbing stimuli. A still further factor to be considered is that the appearance of an EI, or of a certain part of an EI, often depends on the "interests" or the "set" of the subject. A child may be able to reproduce an object, but not the picture of this object, eidetically.

From this it follows that any attempt at determining "laws" in the field of eidetic imagery should take into consideration (*a*) whether or not the phenomena arise spontaneously or under experimental conditions; (*b*) whether the characteristics of the phenomena result from changes in the EI not intentionally brought about by the subject; (*c*) whether the characteristics of the EI are the total or partial result of changes intended by the subject; (*d*) whether there are changes due to "disturbing" stimuli; (*e*) whether "mental set" or "interests" are factors of significance. Some of these factors are beyond the control of the subject, others, such as following instructions or "concentrating" one's attention, are not. The varieties of EI-behavior can be easily understood as resulting from an interplay of the five factors brought out in our analysis. It is this complexity in the experimental findings which should warn us against prematurely "typifying" and establishing "laws."

The problem is complicated by some further observations. There are EI in which successive changes between the original and the complementary color occur. In other EI there appear pronounced contrast phenomena. Such reactions, commonly considered physiologically founded, are absent in other forms of EI; still, this does not mean, as the experiments show, that EI with a large number of physiologically founded phenomena are less easily influenced by the intention of the subject than those EI which, in the sense of Jaensch, are visualized ideas. In eidetic vision we apparently have reactions on different levels occurring *simultaneously* in a fashion not yet entirely understood. In this connection it is worth noting that the observation of a negative AI is often followed by a train of EI and interrupted sometimes by the reappearance of the AI. [It seems that something similar occurs when AI are observed by persons under the influence of mescal; the negative AI may either become part of the visionary designs or in some way "mix" with the mescal hallucinations (24, 26).] For illustration we may quote the case of a Negro boy, aged twelve and one-half years. The stimulus employed was a yellow 5-cm. square with a black fixation point in the center. At a distance of 50 cm. the square was moved up and down before a gray projection screen for about ten seconds. The subject had to fixate the black point during the movement. After the square had been removed, the boy remarked, "Purple box—gone." After closing his eyes, the following was reported:

"Looks like an auto, the curtains are like silver, there is a chair in it in beautiful color—a book, open, but cannot see the letters—something green—a book slanted, a shadow over the book from long

> finger nails, change into eagle claws—triangular windows with black bars in it—a chair again—something in the wall, a Greek statue in marble—(Experimenter: "Can you make it move?")—No, it's gone now—I can see a house upside-down—(Experimenter exerts slight pressure on the eye-bulbs)—there is a doll now—I see a tree—there is a purple blue box falling. . . ." (the experiment is discontinued).

Another subject, while observing an AI, suddenly saw the head of a doll, the doll having been shown to him about twenty minutes before.

In this connection attention should be called to a group of individuals who can produce AI from imaginal objects (MI). We have found such cases only among children, and Jaensch, Freiling, and others have reported similar cases. The child, after imagining, with closed eyes, an object of a certain color, may, after opening the eyes, see the object in its complementary color. Such a child, in describing the phenomenon on the projection screen, may remark, "A minute ago it was blue, but I made it yellow again."

Eidetic Imagery and Intelligence

Zillig (42), Kirek (22), Schmitz (36), Bonte (2), and others have been interested in the relation between eidetic disposition and intelligence. Zillig, in her study of Würzburg children, concluded that strong eidetic imagery is mostly found in children of low intelligence. Kirek reached about the same conclusion in assuming that children with very pronounced EI are not likely to be very intelligent. Both Schmitz and Bonte, in correlating intelligence test scores with the results of tests for eidetic imagery, did not find any correlation between eidetic imagery and general intelligence. Strong eidetic cases were found at all intelligence levels. It seems that the present evidence points to a zero correlation of intelligence with eidetic imagery. A different picture, however, presents itself if the various psychological functions involved in passing an intelligence test are considered separately in their relation to eidetic imagery, or if the different "types" of eidetic imagery are viewed in their relation to general intelligence. Kirek, in studying the "formation of concepts" in children, found that children of Jaensch's B-type had great difficulties in replacing vivid EI by "abstract concepts." Schmitz asserts that representatives of the "unitary type" are above normal in intelligence if their EI are of the B-type, and below normal if they are of the T-type. It is worth noting that, in an analysis of 109 answers given in a Binet Test, 25 per cent of the answers were based on EI and another 30 per cent on the description of MI. Bonte, in administering tests requiring "abstract" thinking, found no difference between eidetic and non-eidetic children. He found B- and T-types on all intelligence levels, but children of the B-type were more suggestible than children of the T-type. Other experiments have brought out the fact that EI are utilized whenever the tests demand concentrating on or observing visual objects, or when they require certain forms of visual memory or imagination. It may be added that Götz (9)

obtained some interesting results from an examination of eidetic imagery in feebleminded children, fifty-eight boys and forty-two girls, ranging in age from seven to sixteen years.

Importance of Eidetic Imagery for Education

While some writers emphasize the great significance of eidetic imagery for classroom instruction, others warn against hasty generalizations in this respect. The analysis of some adult eidetic cases shows the important rôle eidetic imagery may play in studying such things as zoology, botany, or phonetics. Undoubtedly, EI are also utilized by many painters and writers. Children frequently use EI profitably, sometimes with almost unbelievable success, in composition, public speaking, geography, physics, drawing, and painting. At the same time, it is considered a fact that EI interfere with the progress of some pupils. The interesting study of Metz (33) on the relation between drawing and eidetic imagery deserves special mention. Metz found that teachers such as E. Heckmann have been remarkably successful by resorting to eidetic imagery in the teaching of art. Heckmann uses colored spots produced with a brush on wet paper, or pieces of colored paper, or nonsensical configurations of pencil lines in "stimulating" the color sense and imagination. Nevertheless, eidetic children rarely depend on their EI in the sense that they project them on paper and then trace the contours. Politt was able to show, and Metz agrees with him, that tracing the contours of an EI is not possible. The experiments of Metz suggest that the *act* of drawing has not a visual, but a motor basis, and that children's drawings are essentially a form of *language*. It is easily understood, therefore, that the drawings of normal eidetic children are not "physioplastic," to use an expression of Verworn. Schubert's (38) conclusion, arrived at in her study of the "drawings of Orotchen children and young people," that the Orotchen drawings "must obviously be interpreted as the outlining with a pencil of eidetic forms which are projected onto paper" is probably not correct.

It appears that further investigations are necessary before determining to what extent the results of research on eidetic imagery should be taken into account in the teaching of different school subjects. Of greater importance than a possible change in didactic methods is undoubtedly the recognition, on the part of the teacher, that high or low scholarship in certain fields, ethical "defects," as well as the pursuit of certain "ideals" may have something to do with eidetic imagery. The forensic importance of certain kinds of EI should be kept in mind. According to Zillig (43), the inability to describe accurately a past event may have its root in confusion with an EI. In dealing with "behavior" cases, it is well to remember that EI occur in all sense fields. Some years ago, Healy (10) considered the great importance of "criminalistic mental imagery" in delinquent children. It is hoped that future investigations will bring out more clearly the significance of "criminalistic eidetic imagery."

Eidetic Imagery in Different Races

Jaensch believes that there exist differences in the eidetic imagery of different races, e.g., that the fluctuating EI of the B-type are more frequently found in Frenchmen than in Germans. However, in studying the eidetic imagery of Italian, Jewish, and Negro children in different districts in America, we failed to discover marked racial differences. Jaensch states also that an analysis of so-called primitive races points to the conspicuous rôle EI play in the lives of primitives. Again, experimental results to bear out this contention are not presented.

Eidetic Imagery and Constitution

As indicated above, W. Jaensch believes that the differences in EI-behavior point to differences in psychophysical constitution. We shall consider very shortly Jaensch's doctrine of "psychophysical types."

EI are viewed by him as "optical stigmata" closely related to other psychic or somatic stigmata. The EI of the B-type is one in a number of intimately related psychic and somatic stigmata. A general biotype, the B-type, is assumed. The EI of the T-type is one in a complex of related T-stigmata and, therefore, an indicator of another general biotype, the T-type. The relation of these two biotypes to Basedow's disease and tetany are undoubtedly not emphasized at the present time as much as at the beginning of these constitution studies. In his monograph, W. Jaensch prefers to speak of a difference between a B- and a T-complex. In the complex of basedoid symptoms, we have the slight protrusion of the bulbs, wide palpebral aperture, frequent pupillary changes, Möbius' sign, certain cardiac symptoms, exaggerated skin reflexes, tremor of the fingers, etc., while in the tetanoid complex we have an increase in the mechanical and galvanic irritability of the peripheral nerves. The two biotypes, then, are based on clinical observations and the results of an "optical investigation." W. Jaensch presents tables comparing the distribution of T- and B-stigmata and EI in a group having an average age of twelve and one-half years with the corresponding stigmata and EI in a group with an average age of eighteen and one-half years. He draws the conclusion that an "overexcitability" manifested in the form of eidetic imagery shows itself both in the motor and in the sensory field. This "overexcitability," as determined by clinical and eidetic tests, must, he states, be considered normal in childhood. The retreat of the EI during or after puberty is accompanied by a retreat of the corresponding basedoid and tetanoid stigmata. The B- and the T-type hold, W. Jaensch believes, not only for eidetic but also for non-eidetic individuals and for human personality in general. They are true psychophysical personality types. The B-type responds easily to psychic stimuli, whereas the T-type is more likely to react to "exogenous or endogenous physiological" stimuli; the individuals of the B-type tend to "psychopathy," while the T-type tends to "neuropathy."

For a closer study of the doctrine of "psychophysical types," W. Jaensch's

monograph and a large number of medical studies should be consulted. It must be said that the majority of medical investigators trying to verify Jaensch's typology could not find any intimate relation between eidetic images and basedoid, tetanoid, or other constitutional characteristics. The various kinds of conflicting evidence cannot be considered here, but there is no doubt that the empirical basis for Jaensch's contentions is far too limited. It is to be regretted that certain writers, without examining the evidence, take it for granted that EI are definitely related to and are indicators of differences in constitution. In this connection, it deserves special mention that Jaensch's statements with regard to the effect of Anhalonium Lewinii and other drugs on EI, and the effect of calcium on the EI of the T-type, have also not found much support in recent studies. It is of interest that, in the very extensive investigations of the capillaries of the skin at the nail bed carried on by W. Jaensch and his collaborators, AI- and EI-experiments are included in the research program for determining the degree of "optical infantilism" (18). Liefmann, however, reports that she was unable to find any correlation between capillary picture and eidetic disposition.

Eidetic Imagery and Personality

In examining a large number of children for eidetic imagery, one is surprised to find that the majority of eidetic children, even the very strong cases, know nothing about their ability to produce EI. It appears that these individuals have not consciously fallen back upon their eidetic images in reacting to and adjusting to their world. It does not follow from this observation that EI are of little importance in personality development; in fact, the various lines of evidence suggest just the opposite.

It seems to us very likely that a zero correlation will be found between eidetic ability and other abilities, as measured by standardized tests, but we must not forget that "the abilities of man" are probably the least significant chapter in a psychology of personality. "The interests of man," his *Richtungsdispositionen,* to use a term of William Stern, not his *Rüstungsdispositionen*, appear to be far more significant. Some of our findings suggest that interests and forms of motivation may be markedly influenced by the fact that an individual is or is not eidetic.

Another point is to be considered. Eidetic imagery *per se* may not throw much light on the workings of personality, although Kroh (30) maintains that the analysis of EI is a step towards an "objective psychoanalysis." At present it is recognized that differences in eidetic imagery are less important than the differences in the mechanisms operative in intellectual, emotional, and perceptual responses in childhood. No light is thrown on these mechanisms by "measuring" mental and bodily development, since the determination of performance levels does not give us any insight into the psychological functions involved in these performances. The differences in "output" represented by the differences between the test scores of a child and an adult imply differences in ways of perceiving, in

motivation, in intellectual operation—in short, in a number of psychological mechanisms. Fortunately, some experimental data are at hand to support this statement, but nothing is added by "measuring" developmental levels. A genetic psychology, rightly understood, is not primarily interested in the *level* of a performance, but in its *genesis*, i.e., in the psychological functions involved. That there are fundamentally different modes of psychological functioning when reacting to outer and inner stimuli, to the world of men, objects, and ideas is an assumption of Jaensch based on a great deal of experimental evidence. Not only eidetic imagery but also a large number of other mechanisms operative in various reactions have been recently examined. The reactions investigated by Jaensch vary, to express it briefly, from pupillary behavior to aesthetic interests. At present, Jaensch (15, 16) summarizes his evidence for fundamentally different modes of psychological functioning by assuming an "integrated type" and a "non-integrated type," and the study of the close interrelation of different psychological functions has led him to assume various forms of integration (I_1-, I_2-, S-type, etc.). It seems to us that by this new effort, in which the emphasis is shifted from an investigation of eidetic imagery to an all-around genetic study of various psychological functions, eidetic research has found its proper place in a psychology of personality. It remains to be seen, of course, whether future research will substantiate results which, at present, are more suggestive than conclusive.

In closing, it cannot be too strongly emphasized that EI should not be misused as "indicators of" something, no matter whether this "something" refers to deep-rooted personality traits or to ectodermal disturbances. In our endeavor to find "indicators" we apparently very often forget that the phenomena have an *Eigenleben*, a behavior of their own. We believe that in studying this *Eigenleben* as carefully as possible we shall avoid contributing to a psychology of personality based on hasty generalizations.

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CHAPTER 18

THE PHYSIOLOGICAL APPETITES

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It is interesting to note the change in the present point of view from that of psychologists of two decades ago with reference to the physiological implications of psychology. At that time the sciences were very jealous of their domains. Authors scrupulously defined in no uncertain, but far from conclusive, terms the limits of their respective fields. With great chivalry the contribution of one to the other was acknowledged, but neither was permitted without breach of courtesy to intrude upon the other. *This* is physiology; *that* is psychology—and never the twain shall meet. No clearer demonstration of this attitude is needed than a brief perusal of the chapter headings in Wundt's *Physiologische Psychologie,* or in Ladd and Woodworth's *Physiological Psychology*—or, better, the examination of the textbooks of psychology of that period which slavishly abstracted with more or less discernment the material if not the actual substance of these books. The result was, of course, that the authors seldom, if at all, came to grip with the "subject" of the discourses. The individual was represented by a sensation, a feeling-tone, a reaction-time, or a cerebral gyrus. What physiology had to do with human behavior was never quite clear, but diagrams, theories, and intricate, mechanical arrangements showed conclusively what physiology, as psychology, had to do with the eye, the ear, the nose, and, sometimes, the stomach. Sex was seldom mentioned by either.

Surely it is not necessary for the psychologist to presume that a thorough knowledge of physiology is essential to the understanding of psychological phenomena. Obviously, the coordination of all branches of knowledge would make for a clearer interpretation, but to wait for the scholars in each field to exhaust its potentialities would leave the artist nothing to do.

There is still at hand the physiological data concerning the eye to add to our knowledge of seeing. But the act of seeing is a phenomenon which may be studied without the intimate knowledge of lenses. There is still work to be done on fatigue, nerve conduction, inhibition, etc., which would lend itself to a better understanding of behavior, the will, and so on; but the facts of fatigue, activity, and conflict are capable of study by the peculiar methodology of psychologists independently of the pathologist, dermatologist, and theologian.

In the last two decades the child has been discovered, or, perhaps more accurately, rediscovered. Whether credit for this discovery should go to the pediatrician, the educator, the psychologist, or the sociologist need not

concern us here. Sufficient it is to say that there appeared a concerted effort towards understanding this age, and each student claimed his own field, but, instead of the science being uppermost in his mind, there was evident a common ground for meeting, namely, the child. He did not appear as an isolated organ, an attenuated sensation, an ethical quantum, or a complicated theory, but persisted, against all endeavors to the contrary, to be himself. He ate, he saw, he scampered, he lost his temper, he learned, he lived, he functioned, and, rather amazingly perhaps, he grew up into an adult always leaving behind another group of children to be studied. This perseverance on the part of the child to stay coordinated in spite of scientific dissection perhaps had more to do with the present-day communal attitude of the psychologist towards contingent disciplines than any foresight of his own.

Perhaps the most significant trend in modern child psychology is the emphasis placed upon the understanding of the process of learning. The gradual retirement of instincts into the background has made it necessary to understand more fully the means and mechanisms by which the adult, with his complex and variegated behavior patterns, emerges from the all-too-evidently meagerly equipped child.

In this chapter we shall restrict our interests within a narrow limit of behavior. We shall discuss only those aspects of behavior which in childhood appear important from the point of view of training. The child is a biological unit, he must live and grow and assimilate, eliminate, move, drink, eat, etc. The physiologist may tell us of the position of the glands in the intestinal mucosa, the biochemist may tell us of the breaking-up of the larger protein molecules into amino acids, the embryologist may describe in detail the development of the endoderm, the nutritionist may discuss the relative values of the vitamines, but, after all, the psychologist is interested in how the child arranges the conditions for assimilation, i.e., gets the food into contact with the mucosa; why he eats the way he does, and the mechanism by which this eating behavior fits into the larger program of the social life in which he must participate if he is to live at all.

These various biological functions are interesting because they may be more or less adequately described in terms of their common attributes. There are six of these functional organic mechanisms and these may be called hunger, thirst, elimination, change, rest, and sex. For want of a better name they are called the appetitive aspects of organic life, and each may be designated as an *"appetite."*

What are the attributes of an appetite? How may an appetite be defined or recognized?

Accepting the fact that an individual is alive, and leaving for others or for another place the task of discussing the nature of life, we take for granted the obvious phenomenon of "activity." To seek an explanation of activity in terms of instincts is to becloud the issue. Instincts must be narrowly considered as unlearned modes or mechanisms of adjustment. To *"explain"* behavior of any sort in terms of instinct is to sterilize

research. To *"describe"* forms of behavior as instinctive is to say that they are preformed because of certain structural inheritances. Swallowing is thus an instinct. *Why* does a child swallow? Because if he does not swallow he will die of starvation. Is this an adequate answer? Obviously this is a "negative instinct." To ascribe to a child the teleological motive of self-preservation is perhaps satisfying to the eugenicist but certainly not to a scientist. Such an answer would necessitate the assumption that "self-preservation" is a "motive." We cannot enter into this controversy here, except to point out that again there is the danger of sterilizing thought. The child does everything "so that he may live." Why does he want to live? So that he may be alive? And so on.

Appetites, then, are not instincts (by definition). But the child is living and manifests certain forms of activity; he swallows, he cries, he eliminates, he perspires, etc. Unless the child *is* alive, we, *as* psychologists, are not interested in him. We shall accept the phenomenon of *life* as a little-understood phenomenon. Why the child is alive and why he wishes (if he does) to go on living is a fascinating topic for discussion, but we shall leave this battleground to fight a lesser skirmish on another field.

There is still a great deal to discuss, even after eliminating this fascinating field of vital purpose. Why does a child eat potato soup and not spinach? Why does a child learn certain habits of cleanliness? Why does he sleep in the afternoon and not at night, or vice versa? These questions may be answered by observation and experimentation. We may state the hypothesis this way. *At all times a child must react in some way towards his total environment. What are the factors that determine the particular and specific form of response that is manifested at any particular moment?* A child either eats or doesn't eat. Why? A child has regular habits of elimination, or does not. Why? A child either cries or does not. Why? A child masturbates or does not. Why?

Thus if a child is hungry and acceptable food is placed before him, he will eat. If he is not hungry, or if the food is distasteful (for some reason), he will not eat. This situation is capable of investigation without the necessity of asking why *should* a child eat anything or why should a child be interested in living at all. We may state, then, that "hunger" is an appetite, in that certain aspects of human behavior depend upon the manifestation of this phenomenon which is biological, physiological, psychological, and sociological in its implications. An appetite is a *motive.* Not a primary impelling motive. But a secondary *directing* motive. The child *must* do something. We are uncertain as yet as to the explanation of this phenomenon of compulsive activity, but what he does at any moment is determined by certain directive factors among which hunger, thirst, sex, etc., are numbered.

The six "appetites" mentioned above are included in the same category of secondary motives because they have certain attributes in common.

An *appetite* is a secondary motivating factor, influencing behavior in so far as there is the necessity for satisfying a biological need. A group of

organs integrated functionally manifests a definite rhythm in continuously successive cycles, consciously experienced and represented in overt behavior by innate responses later modified by maturation, growth, and definite learning processes. The latter are directed by an educational plan of a more or less formal nature, resulting in a set of habits which adjusts the individual more or less adequately to his environment, physical and social.

Attributes of Appetites

1. *Physiological Background.* If we examine living protoplasm in its simple form, as in the unicellular organisms, we find that the phenomena that permit us to call it living are motility, irritability, conductivity, assimilation, excretion, and reproduction. In the course of evolutionary development there has arisen complexity of structural mechanism but very little change in fundamental functioning.[1] The physiologist studies these various phenomena separately and also their interrelation. The human child manifests all of these functions. Because of structural specialization, it is necessary from the psychological point of view to include certain aspects of functioning under separate categories. Thus ingestion of food is included under hunger; ingestion of water, under thirst; elimination of waste products, although an integral part of the assimilating function, is considered under the category, elimination; and so on.

Motility, irritability, and conductivity are common to all behavior and so are not considered separately.

It must again be stressed that a complete understanding of the physiological data concerning these phenomena is unnecessary for a fuller psychological analysis. If this were necessary, we as psychologists would wait expectantly and idly until the physiologist had solved all the problems in connection with those phenomena, e.g., fatigue. The absurdity of such a contention is self-evident. To be sure, newer physiological concepts will reflect new insights into psychological inquiries, but it is not the task of the psychologist to initiate or to undertake such inquiries.

Each one of the appetites, e.g., hunger, is concerned with definite physiological functioning—salivary digestion, esophageal peristalsis, gastric digestion, admixture of gastric secretions to the food mass, alkalinity and acidity, the pyloric mechanism, duodenal digestion, pancreatic enzymes, intestinal peristalsis, the activity of the mucosa, Peyer's patches, coecal stasis, etc. To describe or discuss even briefly this data would be an arduous task. It is far better done in a textbook of physiology. For a complete understanding of the whole mechanism such a study would repay itself. There are, however, other aspects which are wholly in the field of the psychologist and these will be stressed.

It is sufficient to say that each of the appetites is concerned with some aspect of the biological functioning of protoplasm in its primitive or spe-

[1]Consciousness—there is no need here to enter into the controversy as to whether amoeba are conscious or not, or, if not, at what stage in the evolutionary scale consciousness intervenes. At any rate, it is not a new biological phenomenon.

cialized state. A localized organic grouping affords the opportunity of classifying each within some sphere of apparent interrelated activity, permitting discussion on a more or less systematic basis.

2. *Rhythm.* Another aspect of the appetites is the marked rhythm apparent in their functioning. There seem to be three periods of activity composing a complete cycle: First, a gradual increase in the physiological tension necessitating a need for some form of satisfaction accomplished by environmental adjustment of some sort. Secondly, the arrangement of this satisfaction brings about a period of activity more or less prolonged in which the individual actively participates in an obvious interplay between himself and the environment. Thirdly, a period of rest and quiescence followed by the first period, to begin the cycle again. Calling these periods first, second, and third is wholly arbitrary because they follow closely upon one another and it is difficult to state when one begins and the other ends, and which is the first. The period of rest is only apparent and not real except in terms of obvious overt behavior, e.g., the first period in hunger is the growing demand on the part of the child for food—a general restlessness and perhaps vocal patterns exhibit themselves; the environment is arranged so that these demands may be met—the child eats, and during that eating this demand becomes less and less until the child is satiated; after which a period of quiescence sets in (as far as this appetite is concerned), until, again, the demand gradually makes itself felt. These cycles follow one another from birth until death. At *all* times the child or adult is at some stage in all of the six cycles. Each appetite has its own rhythm, the regularity of which may be altered by circumstances or by training as will be seen in the following discussion of the particular appetites.

3. *Conscious Aspects.* Listed among the sense modalities there is usually a category called the "organic sensations," such as hunger, thirst, etc. They are not localized, definite, and classifiable as are the more amenable sensations, such as vision and audition. There is no convenient sense-organ to extirpate or interfere with, and so very little experimentation has been done upon them.

The Gestalt school would find these sensory experiences more suitable for expounding its theories of configurations than any of the others, and they are perhaps more indicative of the perceptual nature of conscious life than are the disparate characteristics of the more commonly discussed senses. There is a perceptual background to the entire cycle of each of the appetites. We are accustomed to think only in terms of attended-to aspects in thinking of the organic senses. Thus hunger is commonly thought of as a "sensation." It is obvious, however, that during the whole cycle the physiological status has perceptual attributes. It is only at the climax of the preparatory stage that we think of the sensory experience as "hunger." We neglect the sensory complements of taste, touch, temperature, etc., that accompany eating; the conscious experience of distention and repletion after a full meal; and so on. These conscious aspects

of the appetites are most important in learning to adjust to the environment, e.g., the sensory components or configurations in the appetite of elimination from the bladder, alone make it possible for the child to learn the necessary control.

It is then necessary to think of the conscious experience of the whole cycle or rhythm rather than to think of a specific sensation, organic or otherwise, in connection with each appetite. This will be discussed at greater length under each appetite.

4. *Innate Response.* In connection with each appetite there is a specific form of response present at birth in the normal full-term child which makes possible an adequate and satisfactory adjustment, providing the environmental factors are propitious. Thus the child, if given food, is able to suckle and swallow, thus initiating the whole digestive process which proceeds automatically to its conclusion. The bladder is capable of being emptied when necessary. The child can fall asleep when tired, etc.

These responses are adequate and apparently unlearned. If an instinct may be defined as an unlearned form of response to specific situations, then these *responses* are instinctive. The term is included here lest it be interpreted in some other aspect of the discussion of these appetites, incorrectly.

5. *Modification of Innate Response.* There are two factors which tend to change the original form of response called forth by the appetites. The first is *maturation* or developmental growth and the second is *learning.*

By maturation is meant such factors as the appearance of teeth, making solid foods possible as articles of diet; the pubertal changes in sex organs; the increased size of the bladder; etc. Growth itself, increase in stature and musculature, modifies the gross skeletal responses, e.g., the holding of a glass for drinking differs from drinking through a nipple.

The second factor is perhaps more important, at least it appears more complicated. In so far as our total adult adjustment to social situations is learned, aside from the relatively meager instinctive repertoire in humans, the mechanism of learning is very significant. In fact, as mentioned above, one might base one's entire philosophy of living upon the laws of learning.

In connection with this second factor we must distinguish two aspects. The first aspect is that of personal enjoyment of appetitive experience. Each of the appetites excites certain demands or needs. These must be met if the individual is to be satisfied. The personal reference to the mode of satisfaction of each specific appetite is exceedingly important in the development of the individual self. In so far as the appetites *must* be satisfied in some way if the individual is to retain his biological integrity, it seems rather odd that so little emphasis has been placed in child training on the necessity of meeting these needs in ways which will lead to their enjoyment by the individual. He should enjoy his food, his drink, his rest, his eliminative functions, his interests, and his sex activity. It is not necessary to mention here, because it will be stressed later, how few of

these appetitive responses are looked upon as legitimate sources of enjoyment. Perhaps our Puritan social inheritance or the traditional self-righteousness of the Anglo-Saxon has led to this neglect. Sufficient it is to say that in the field of child training an attitude of hedonism in the realm of appetitive satisfaction is not only sound but also empirically efficient.

It is necessary to expand more fully concerning the concept of "enjoyment." The tastes of an individual, his likes and dislikes, depend upon the training, formal and informal, which is initiated in connection with the attitudes. No longer are "pleasantness" and "unpleasantness" thought of as elements of conscious experience but rather as perceptual experiences of environmental situations in terms of the gross response of the individual.

Thus, if an individual "accepts" a situation, which means that he acts in such a manner as to remain in the situation or to permit the situation to continue, then his attitude is said to be one of *approach*. On the contrary, if he rejects the situation, in whole or in part, or withdraws therefrom, his attitude is one of *withdrawal*. Of course, later on, he will *say* that he accepts a situation because he likes it and rejects another because he dislikes it or it is unpleasant. But this explanation is really putting the cart before the horse. It is his response which determines his perceptual interpretation. He accepts and therefore he likes or it is pleasant. He withdraws and therefore he dislikes or it is unpleasant. As can be seen it is the total situation which determines the perceptual experience, the attended-to aspect as well as the background. By background is meant not only those aspects of the immediate situation to which he is not directly attending but also his total past experience.

Thus, one child dislikes spinach. In other, and more accurate, words, he will not eat (accept) it. Why not? Because of the taste? color? consistency? Perhaps. But more than likely his refusal was determined by the fact that this food was first offered to him at a period of emotional upset by a person towards whom the attitude of withdrawal had already been set up. He is therefore refusing not only the spinach, but, more important, he is refusing to participate in the whole situation, past and present.

By "enjoyment" is meant the set of habits of acceptance of certain situations built up in the child from infancy onwards. These situations he will then call pleasant and he will say that he enjoys them.

In connection with the training plan of this aspect of the modification of the innate responses of an individual, it will be seen that there are two items to be kept in mind: first, to arrange the specific factors leading to the satisfaction of the biological needs indicated by the appetite in question; secondly, to arrange the attendant or contributory background factors so as to assist in the general purpose of developing acceptance in the child.

Hence we eat food to satisfy the nutritive demands of the body but we also arrange the situation in such a way as to enhance the enjoyment:

clean linen, shining silver, soft lights, congenial companions, and (in the adult) perchance an aperitif. The proteins, carbohydrates, fats, and vitamines are not biochemically changed by these factors[2] mentioned, but the enjoyment of the individual is more certainly assured.

What is true of the appetite of hunger is true of the other appetites. It is possible to outline a program of training which will accomplish the results indicated. There should be no controversy as to their desirability. It is hardly necessary to point out that with reference to the appetite of sex exactly the opposite plan of training has been followed.

In the following sections, this aspect of the modification of the innate responses will be discussed under the separate appetites.

The second aspect is the inevitable conflict that arises between the satisfaction of the individual needs and the rules and regulations laid down by social customs and traditions. These latter are usually inhibitory in character, e.g., there are definite ways of using a knife and fork, there are definite times and places in which to urinate, there are restrictions upon sex activity and interest. These rules are indigenous to the social group in which the child lives and, needless to say, are usually quite arbitrary in form, differing from group to group.

It is in the resolution of these conflicts which are bound to arise that the training difficulties lie. An educational program (bringing up children) is directed towards *teaching* the child to act in accordance with the principles of social usage. This teaching usually stresses the necessity to conform and seldom stresses the necessity to enjoy, as mentioned above.

An ideal program would be one that could enable the child as he grows and matures to enjoy the appetitive experiences in accordance with the necessary restrictions placed upon him by his social group.

6. *Maladjustments.* This term is used advisedly and will be defined as clearly as possible to avoid the unnecessary distrust that has become associated with it. Although this article is dealing only with the so-called normal development of children, it is a mistake to think that all difficulties of adjustment *can* be avoided in child training. It is just this fact that makes a section on this subject of maladjustment necessary. If, as will be discussed, one looks upon these apparent aberrations in behavior as necessary steps in learning they cease to have a pathological significance and so fall into the "normal" plan outlined here.

We shall see that in connection with each appetite there are aspects of behavior which seem unsuitable—to other persons: feeding problems, bedwetting, restlessness, masturbation, inattention, etc. These are commonly considered misdemeanors, by some persons even as *crimes*. We shall at-

[2]The physiologists will tell us that if there is some preparatory phase to the presentation of food such as display or savory odors, there will result a preliminary salivary secretion (mouth-watering) which in turn, by means of hormones, stimulates the gastric juices to be secreted into the stomach prior to the reception of the food. This physiological phenomenon is only *one* aspect of the concept of "enjoyment" and should not be confused with or made the organic counterpart thereof.

tempt to point out that these forms of behavior are common and universal phenomena in the learning processes of children, proceeding from infancy to adult life; that they are part and parcel of life and that too much significance is attached to their seemingly *abnormal* aspect and too little to their value in the total learning scheme.

What then *is* maladjustment?

Adjustment, as a term in human psychology, has no doubt been borrowed from the field of biology. An organism is pictured in its environmental milieu, and the development which it undergoes is considered to be a series of adaptations to the changes in the surroundings. The organism adjusts to its environment. Child has shown that the early division of the egg, the direction of dominance, the radii of symmetry, are determined by influences called in part physiological gradients, initiated by physicochemical changes capable of identification.

Sometimes there are changes in the environmental picture which might be termed "accidents," in that they are not common to the group, e.g., the end-bud of a growing plant may be detached, the consequent adaptation or adjustment being the assumption of dominance by one of the subsidiary buds. There is always a trace of this phenomenon, a scar as it were, represented by the slight irregularity in the stem at this point. Whenever an organism adjusts to the environment, whether in a regular fashion or towards some unforeseen event, the mechanism of adjustment is apparently the same, an attempt to survive or to approximate a given norm. The norm is established or may be recognized by observing the growth of the great number of organisms in a suitable or adequate environment.

When we turn to consider the human field we are immediately confronted with an added factor. The many individuals which constitute a social group must grow up not only in an environment of biological influences but also of social influences. Under the former, the adjustment is perhaps comparable to the plant or animal, e.g., the migration of leucocytes into a traumatic area, vascular and pigmentation response to ultraviolet rays, the growth of a callus at the points of continuous pressure, etc. These are "adaptable" adjustments.

The adjustment to social influences, however, involves not only the response to the circumstances of the moment, but the individual must also consider the judgment of the remainder of the group. The hungry man adjusts by stealing, the angry man adjusts by murder, the boy adjusts to anticipated defeat by copying, the child adjusts to frustration by a temper tantrum. To these individuals the responses are as much "adaptable" adjustments as the examples quoted above; on the other hand, social judgment announces that these are not socially adaptable and hence are *mal*adjustments. One may talk of a maladjusted plant, but it would have no significance. In the case of the plant, the norm of growth is readily ascertained and relatively fixed; in the case of society, the norm is difficult to state and is most unstable, changing with each decade of social life. The sins of today are the commonplace behavior patterns of tomorrow.

One may define maladjusted behavior as "acts" which require or call forth interference on the part of other members of the community.

Whenever it is necessary for the life of the society to be halted in order that one member be "disciplined," this may be said to be a maladjustment. As society grows in numbers, a certain group of people must assume this responsibility, i.e., judges, policemen, lawyers, etc., and from the number so engaged it is quite apparent that maladjustment is no uncommon phenomenon. Furthermore, history reveals the fact that this condition has existed for a long time.

As society becomes more complex the defining of norms becomes a delicate task. Ideally it would be the expression of universal opinion. However, in so far as the group is a collection of individuals, we find the expression of the norm taking the form of personal judgments and the redress one of individual indignation and demand for personal satisfaction, the *"lex talionis."* The code of laws and the code of morals or ethical behavior are by no means identical.

If child training means anything at all, its significance is an emphasis upon prevention of maladjusted behavior, not punishment of "criminals." The point of view of the student in this field is the one described above, i.e., the child is born into a complex social environment. He grows up. He meets a changing environmental situation. He adapts to this according to his potentialities. If "by chance" his behavior is such that if it should continue society would be endangered, steps should be taken to change the environment so that he may learn a substitute for this behavior. There should be an opportunity to *learn* how to adjust. To call it *mal*adjusted is a misnomer. If all the circumstances were known it would probably be *adjusted* behavior, i.e., *an act which every one of us would have employed in the same situation.* There can be no moral obloquy for an act conditioned by circumstances which are beyond the control of the individual, unless, of course, one adopts the theory of original and predisposing sin with all of its moral and ethical implications. To do this one would have to step out of the rôle of the scientist into that of the theologian.

The child who masturbates, swears, wets the bed, regurgitates his food, etc., is impelled by the same motives, urges, and purposes as the child, if there be such, who does not commit any of these acts. There does not appear to be any *new* motivating factor in a delinquent child as compared to a non-delinquent child. Analysis, questioning, delving into his (or her) "innermost thoughts," yields the same ambitions, wishes, yearnings, wants (a different content perhaps) as in the so-called model, good, or well-adjusted boy or girl. We have been looking for a will-o'-the-wisp—viz., the perfect child. It is like the old concept of the "feeling-tone" which could not be introspected. It could not stand the light of attentive inquiry. It was a long time before psychologists adopted an empirical attitude towards this phenomenon and said, "Perhaps it does not exist at all in the form we have been describing."

Let us try to learn how a boy or girl of three years, five years, eight

years, twelve years, actually lives during the twenty-four hours of the day in the light of the theory of appetites here discussed.

Of course the appetites are just one aspect of the motivating complex of human organisms. The attitudes or tastes, the emotional life, the growth of the self, are not discussed although they should be if we were envisaging a total scheme of motivation. But, in so far as the appetites are biologically and psychologically dominant, this paper will serve as an introduction to such a scheme. Furthermore, the fundamental training of children with reference to these appetites takes place in the first five years (even with sex), and so one may without prejudice emphasize the importance of some scheme, however much it may be changed or modified after additional study and research.

Each appetite will now be discussed separately under the headings enumerated above.

Hunger

1. *Physiology*. A comprehensive survey of the physiology of ingestion and digestion would be a task of some magnitude. We shall therefore refer our readers to any standard text in physiology for details.

Especial attention should be paid to the muscular action of the lips, cheeks, and tongue in early infancy: the salivary digestion; the hormonic relationship between oral digestion and gastric digestion; the gastric juices and their action on foods; the neural and chemical relationship of the muscular activity of the cardiac and pyloric sphincters; the digestion in the duodenum and jejunum; the action of bile on fat digestion; etc. The student of child development should be acquainted at least with the gross features of these phenomena.

2. *Rhythm*. As in all the appetites there are three recognizable planes, a period of restlessness manifesting a "need"[3] on the part of the organism, a period during which suitable environmental arrangements make satisfaction possible, and then a period of repletion and rest. Minutely accurate delineation of the end or beginning of each phase is uniform, then, but each may be recognized at some point of its manifestation. The first stage is indicated by restlessness, complaining, and other evidences of dissatisfaction; the second, by the obvious behavior pattern of suckling, swallowing, and, later, chewing; and the third, by a quiescence and an apparent indifference toward this biological function permitting other aspects of biological activity to assume prominence, e.g., sleeping.

In a later paragraph the regulation of this rhythm will be discussed. At present it is noted that, at whatever place in the cycle this appetite begins, there is a regular progression of the three phases which endures until the death of the organism.

[3]Later on, in the development of the individual, when he *learns* to interpret the significance of the total situation, viz., that the experience is one of hunger and that food will satisfy, we might say that he has a "desire" for food. The appetite may be called the *motive,* food may be called the *incentive.*

TABLE 1

TABLE OF APPETITES

Appetites	Physiological background	Rhythm	Conscious aspect	Innate response	Maturation	Modification Learning Enjoyment	Modification Learning Social control	Maladjustments
Hunger	nutrition digestion metabolism	controlled arbitrarily 4-6 times daily in infants 3 times daily in adults	hunger "appetite" "gnawing" repletion	suckling swallowing biting peristalsis	eruption of teeth change in enzymes more efficient musclular activity	appropriate preparation of food companionship cleanliness idiosyncrasies	table manners tabus on certain foods courtesies, etc.	food refusals regurgitation peculiar likes and dislikes
Thirst	physiology of blood, lymph, and other biological fluid media	not regulated irregular rhythm dependent upon changing metabolic circumstances	thirst—fairly definitely localized	swallowing	change from suckling to drinking response	cleanliness added flavors	very little except in matter of drinking noiselessly	refusal of fluids rather rare (except specifically, e.g., milk)
Elimination	secretion of kidney large intestine autonomic nervous system	regulated as to place individual rhythm as to time somewhat dependent upon climatic conditions	"urgency" pressure kinaesthesia and touch	defecation micturition respiration perspiration	more efficient nervous muscular control (suggestion of late medullation of neurons involved)	cleanliness rarely emphasized	shame modesty sanitation	incontinence inability to initiate act
Rest	fatigue neuromuscular functioning	in infancy alternating with other physiological rhythms in childhood twice daily in adults diurnal rhythm	"tiredness"	sleep relaxation	apparent decrease in need of sleep	clean and pleasant appurtenances quiet and peaceful surroundings	times for sleep determined by economic needs	restlessness nightmares somnambulism insomnia
Change	adaptation attentive adjustment	wide individual differences dependent upon habits of routine behavior	"ennui" boredom "excitement"	compulsory change in sensory adjustment (cf. ambiguous figures)	change in range of sensory discrimination (?)	varied interests hobbies recreational routine	morals	inattention lack of concentration no ambition "lazy"
Sex	reproduction erogenous zones hormones	wide individual differences irregular in humans	localized sensory experiences general tension tickle (?)	*manipulation*; and, later, copulation	pubertal changes, structural and *functional* potency	aesthetic development compensatory behavior rational attitude towards growing **hetero-sexual** interest	restriction of active behavior modesty, shame monogamy legal aspects	masturbation promiscuity frigidity impotence

3. *Conscious Aspect.* It is begging the question to assume that "hunger" is a simple sensory experience similar to the color "red."

Although there appears to be a specific, more or less localizable experience which is manifest during the first phase of the cycle and has been more or less correlated with gastric-juice statistics, this is by no means the only sensory aspect of this appetite. Each phase of the cycle has sensory components which may be analyzed separately from the total situation but in such an analysis they lose their significance in the general mosaic. At any time in the whole rhythm, attention may be directed towards one or more aspects of the conscious experience and at all times *some* sensory aspect may be recognized.

Although it is impossible to determine whether the child at birth experiences the same "gnawing" as does the adult, there is no proof to the contrary. That this experience should later be distinguished as "hunger" is not to be wondered at. This experience is no doubt closely related to the restlessness of the child during this phase, but this restlessness is itself a component part of the hunger situation and is itself recognized by its sensory cues.

Although the relationship between biological needs and the sensory experience of the individual has never been clearly envisaged, there is no reason why this need for "food," "fuel," "oxidizable substance," or "tissue repair substances" should not be manifested by some cognitive experience. This may explain the "diffuse" nature of this experience, which we are trying to emphasize. It may also explain the so-called "physiological appetite," e.g., the craving for salt, greens, etc. Later on it will be indicated how little attention, in our Western Civilization, we pay to the total milieu, with reference to this appetite, which may explain how little we realize the subtle nuances of this phase of appetitive activity.

In the second place the estimation is even more complicated. This is the phase of satisfaction, and it is obvious, even upon brief analysis, that all of the senses participate in the experience of the individual.

Taste, a relatively circumscribed sense modality, is, of course, involved, but there is also included smell, which mediates the flavor of food; temperature; kinaesthesia, by which the consistency is appreciated; touch; vision; and even audition.

In addition to these senses there is the experience of distention of the abdomen and, with the satisfaction of the appetite itself, relaxation and lassitude, when in the third phase.

This description is not intended to be a comprehensive or exhaustive picture of the perceptual aspect of this appetite, but is suggestive rather of the complexity of the conscious experience which is "continuous" and not discrete as is commonly taught.

4. *Innate Response.* It is a very fortunate circumstance that the whole mechanism of ingestion and digestion is organized at birth. Who, otherwise, would have the temerity to outline a system of education for the learning of this behavior pattern? To be sure, in premature infants,

there seems to be some disorganization or, rather, incompleteness. The children are fed under rather careful arrangements. But it must be remembered that the fond hope is tacitly expressed that they will live long enough for the performance to mature. Nothing directly is done in the way of teaching.

It must also be remembered that very little modification of this performance occurs during a lifetime except in the direction of pedagogical phenomena. What modification takes place is in the overt: from adjustment of the individual to environmental demands and structural maturity and not in the inner nicely adjusted mechanism.

5. *Modification*

a. Maturation. Aside from actual increase in size, there are several qualitative changes that affect this appetite as indicated in the structural and consequent functional development. The eruption of teeth, beginning about the sixth month, makes it possible, if not imperative, to include some solid foods in the diet. Whether there are changes in the type of enzyme in the gastric secretions coincident with the additions of more varied substance in the food is still a matter of controversy.

The change in the gross structural organization and growth, of course, makes possible the enormous modification in the abundant responses necessary for satisfying the appetite in a manner acceptable to the social customs of the community.

b. Social control. In so far as the child is helpless, except for care of some sort, it would not be surprising to find the regulations of this appetitive behavior subject to the convenience of those who have to supply this care. In other words, by someone, the environment is arranged so that the needs of the individual with regard to hunger are satisfied. How arbitrary is this regulation may be somewhat of a surprise to one who has not considered it.

The three-phase rhythm, described briefly above, is manifest from birth, as mentioned. The pediatrist has acknowledged the presence of this rhythm by arranging definite periods at which it should commence. The average normal healthy child is fed at four-hour intervals, on the hour, at 6:00, 10:00, 2:00, 6:00, 10:00—and then a long period of rest (after a few weeks) until the following 6:00 A.M. feeding the next day. Now it does not matter at what time the child is born, the following day this routine is established and as far as results show it is not only adequate but far better biologically than the haphazard schedule of pre-pediatric days when a child was fed every time it cried (i.e., grew restless). There is no doubt that these "children of freedom" were hungry every time they were restless and that their physiological background was similar to the present-day routinized child who, because of his training, is hungry only according to the clock. The important point, and it cannot be too greatly emphasized, is that, by this very training, the rhythm of the appetite's functioning is regulated and, furthermore, being regulated, the conscious aspect also is controlled. In other words, not only is the biological need

of the child adequately satisfied, but the child is *hungry* at these intervals which, instead of being 6:00, 10:00, 2:00, etc., might just as well be 6:15, 10:47, and 2:16. However, it is easier for the parents, nurses, etc., to maintain regularity at the hour than at varying intervals. Also, the elimination of the early morning feeding at 2:00 (if it is initiated at the beginning) is not because of any physiological need for a long rest period at this hour but because that is when the parents wish to have a rest and also, it is hoped, the child will learn to rest.

If this appetite, alone, were to be considered it would probably be more conducive to health to feed a child less food per feeding but more often. In adult life this arrangement would probably prevent the various gastric distresses to which we are heir because of the sudden distention three times a day. This of course is not substantiated scientifically, but there is no proof to the contrary. However, this latter technique is employed in undernourished children and in adults with duodenal ulcer. In conclusion, let us repeat that the establishment of the particular rhythm is arbitrary and should be arranged to suit the convenience of society provided that the individual needs may be met at the same time.

It must not be overlooked that this regulation is important, not only specifically as it affects the appetite of hunger. This control ushers in, perhaps, the first of the conflicting situations in which a child finds himself. The regular four-hour interval cannot be accurately attuned to *all* children and yet in a few weeks they have learned to adjust to this routine. The conflict has been satisfactorily resolved by temporal suppression or postponement of the rhythm phases until they fit the new requirement. This type of resolution of a conflict is of course eminently satisfactory and satisfying. The compensatory mechanisms of crying or complaining apparent in the initial stages disappear and the child accepts the routinized arrangement fully *by being hungry* at these times rather than at vicarious times. What better arrangement could be made? It is well to keep this in mind as true of all the appetitive activities because this phenomenon appears in connection with all of the appetites. The early resolution of such conflicts emphasizes the importance of training and control of the appetites in the first five years. The conflicting situation is as acute as any conflict subsequently to arise, the period of resolution is as distressing as at any future time, but, adequately resolved, the curtain of amnesia which descends on our childhood admirably protects the individual from the so-called scars that, by then, are adequately healed.

It must be emphasized, however, that this regulation of time is only *one* of the social astringents that are applied. It may safely be conjectured, however, that it is perhaps the most important of all, and the maladjustments, later to be discussed, may more often be traced in origin to inadequate arrangement of this aspect of learning to adjust.

The next important item of social interference is the process of having the child emancipate himself from the state of helplessness to one of independence. The child at first must suckle, but beyond this nothing

further is required. The food is prepared (either breast or bottle) and presented in a form which is attainable and digestible. Gradually, more and more responsibility is thrust upon him. He must hold the cup out of which he must drink and not suckle. He must learn to take food from a spoon. He must learn to hold the spoon and convey the food from the utensil to his mouth. Then he must learn to use a fork, then a knife, and when to use them; and, depending on his social status, he must learn that differently shaped spoons, knives, and forks are used for different foods and at different times.

Again let us be clear in our conception of these rules and regulations. A child could be kept alive and nutritionally well throughout a long life as bottle-fed. It would, of course, mean the dissolving of most foods and the reducing to small particles of the indissoluble foods. But theoretically it could be done. There is nothing except convenience in having the child learn to feed himself and nothing but social antiquities in the more formal feeding customs. This is in no sense a criticism thereof. These customs do no harm except when they are construed as biological essentials rather than social essentials. Furthermore, since these customs are arbitrary in their origin, not only must the child be expected to learn to conform, but an adequate educational program must be arranged and as much patience shown in this educational achievement as in any other.

In so far as the dependence of the child upon early care is a delightful and satisfying escape from responsibility the early training towards independence is a necessary function of the *total* personality. If children were expected to be dependent all their lives upon someone else, then no harm is done in keeping them dependent. The difficulty arises, however, in the fact that as the child grows older he *must* accept more responsibility for *all* of his behavior, not only with respect to eating. Thus an early emancipation in eating habits is necessary not only *per se* but because of its enormous influence on later behavior. The so-called fixations of the psychoanalytic school originate more frequently with respect to this appetite than to the one they most frequently mention.

The next aspect of social control is *what* the child is to eat. Some societies spurn human flesh, others do not. Peoples of certain nations eat snails; others, plum pudding; others, birds' nests; others, pie for breakfast. It is unnecessary to comment on the arbitrary nature of these choices. A suitable food combination includes carbohydrates, fats, proteins, vitamines, salts, and roughage. (By the time this goes to print some new but important ingredient may have been omitted.) The actual *form* of the combination is a matter of personal preference based on *training*. As Davis (28) has shown, we are spending too much time in vigorous control of the percentages of these ingredients and depending too little on the appetitive demands of the individual. This will be discussed more fully below under the heading of personal satisfaction.

The arbitrary nature of the social choice of foods, however, must be emphasized because whenever an arbitrary form of behavior is *demanded*

there must be an ample provision for education. How askew this educational program may become can be illustrated briefly by the attitude developed in the past decade toward the *need* for spinach in the diet of infants and the gradual disappearance of this attitude when its wholly nonsensical results became apparent. To put it bluntly, if spinach is necessary there is a way to get it into a position where it will do most good (i.e., in the child's stomach). If it is not necessary, why bother?

And so there are three aspects of social control: regulation of time, regulation of overt behavior, and regulation of content. Providing we accept the arbitrary nature of these demands, begin the teaching program early, and present reasonable opportunity to the child to learn, there should be no difficulty in the child's adjusting in a manner satisfactory to society and to himself.

c. Individual satisfaction. It follows that the development of individual satisfaction will be concerned with the same aspects of this appetite mentioned above in connection with social demands. The first point to discuss is that of routine. It is apparent that when an arbitrary routine is inculcated it will be at variance with the individual rhythm of the organism which depends largely on the innate make-up. It was pointed out above, however, that if the routine is begun early and is consistently applied the child accepts this arrangement, provided that the appetitive demand is satisfied at the regular intervals arranged. The child is quite satisfied with the five meals a day (later four, and finally three), provided this is a biologically adequate provision. If, however, there is little regularity to meal hours, and the child is sometimes fed because it is crying and because this is one way to settle the immediate behavior problem, then the child is justified in attempting to arrive at this solution at any future time. In other words, the training is towards an acceptance of the routine by the child and not merely for the purpose of regularity.

The second point is the regulation of overt behavior. The child is later to drink from a cup rather than through a nipple. Emphasis was placed above upon the training program. If there is a sudden change of technique, or if the child is so dealt with that resistance of a vigorous sort is called forth, then the subsequent training is more difficult. On the other hand, if care is taken to see that the demand is *not* made before the child is sufficiently mature to learn the necessary muscular response, the novelty of the cup lends itself to the gradual "weaning" of the child from one form of response to a more mature one. Children will resist anything suddenly introduced or anything that is too much at variance with the *status quo*. This is one of the situations towards which an attitude of withdrawal or rejection is called forth. But children are interested in new aspects of living if they can use them creatively and productively.

In the nursery school, for example, where there are a number of children, it is a simple matter to lead a child step by step to a mature form of eating behavior. If in the home this same, sane atmosphere of helpful patience pervades then no difficulty presents itself. When, however, the

tutor expects too much of the child or deprives the child of the opportunity of learning and then suddenly expects him to conform, there is bound to be a "problem."

With proper training the child learns by seeking to achieve the goal of more intricate manipulation. (See appetite of *Change,* below.)

Later, when the traditions of politeness, finesse, and artificial rules are necessary, they are taken by the child in his stride because his training heretofore has prepared him for this very thing—viz., acceptance. To expect a child, at too early an age, to say "please" and "thank you," and to eat soup silently and to keep his napkin on his knee is to expect the Australian aborigine to understand calculus before he knows number.

The final point is that of content. It is with respect to *what* we eat that there is infinite possibility of individual satisfaction without encroaching too far upon the precepts of social usage.

As mentioned above, there are many of the sense modalities involved in the satisfaction of this appetite. It is erroneous to think that taste is the dominant conscious experience in satisfying hunger. As is known, there are only four taste qualities, sweet, salt, bitter, and sour. Of these four, none are much in evidence in breast milk or in the artificial foods given to young infants. The two sensory aspects of foods which are important in feeding are temperature and consistency (kinaesthesia or touch). If there is any wide departure from the usual standard in either of these two aspects the food is rejected. But as the child grows up the other modalities are involved, perhaps in the following order: taste, vision, and, finally, audition (as in eating celery). In the adult who has had a sophisticated training in the whole gamut of food experience, all of these modalities combine to make each meal a most interesting and at times an exciting affair.

If, however, the training has been such as to emphasize only the nutritive aspects of food, "Eat what is good for you," "Be sure to take your cod-liver oil," "What about your vitamine B?" Have you had your iron today?" "Yes, you must finish your spinach," then the mealtime is a chore, to be gotten over with quickly, or, more frequently, to be dawdled over, with the hope that something extraneous to the feeding situation will arise, which is more interesting, whether it be a scene, a book, a pet, or punishment. In childhood are manufactured the adult dyspeptics who grace our tables with boring references to their idiosyncrasies and fill the empty gaps in the conversation with disgusting details of their innards and the boon of bicarbonate of soda.

Does this mean that children should be allowed to eat what they like? No. They should be trained to like what they eat. How can this be accomplished? It is to be remembered that any intense sensory experience is rejected by the child. All bland foods are initially accepted providing they are near body temperature and of smooth fluid consistency. By feeding at regular intervals, avoiding an exciting atmosphere, and arranging for a complete environment of acceptance, the feeding period is no trouble

to the parent and is enjoyable to the child. As the child's sensory horizon recedes, there is added to the feeding situation, *gradually,* all of the attendant sensory experiences: bright, clean utensils, companionship of his own age (or, if adult companionship, then non-interference, complacency, absence of nagging, and patience). There should be no concern on the part of the parent whether the child eats or not. If he refuses one meal he is bound to accept the next one with more enthusiasm. No child has voluntarily starved himself to death, but the threat of starvation has been used in many a home long before this technique acquired political significance.

As he grows older, the infinite variety of possible enjoyment should be unfolded. One can see the deadening influence of our training of children by the lack of imagination on the table of the average home. The weekly luncheons of the well-known service clubs are evidence enough that here is one aspect of physiological enjoyment that we have sadly neglected in our utilitarian civilization. An epicure is looked upon as a species apart and something sinful and perhaps sensual. Of course he is sensual. It is a sad commentary upon our civilization that "sensual" has come to mean something rather esoteric connected with sex, rather than the good Anglo-Saxon meaning of sensory enjoyment of food, comfort, sleep, effort, etc., as well as sex.

We spend time and money teaching our children to enjoy the aesthetic experience of a symphony. A symphony is a more or less pleasing combination of tones continuing for greater or shorter length of time, nothing more. Here, only one sense modality is employed. In the satisfaction of the appetite of hunger, nearly all of the senses may be utilized, and yet we spend no time in teaching the children the infinite possibilities of aesthetic enjoyment. We are too much engaged in getting in the requisite number of calories, the touch of vitamines, and the soupçon of phosphorus for the teeth.

Thus the prime necessity for developing individual satisfaction is to have children brought up in an intelligent appreciation of food and its attendant potentialities.

6. *Maladjustments.* As indicated in the introduction, problems that arise in the course of development must be looked upon as deviant aspects of the learning process.

A brief list of the more important "problems" would include eating between meals, irregular appetite, finicky eaters, refusal to drink from a cup, refusal to feed self, total refusal of food, etc.

As can be seen, these various forms of behavior may be analyzed in terms of the faulty training program employed. It is more difficult to re-initiate a sound basis of training than it is to start the program correctly.

Eating between meals, or demanding food between regular mealtimes, is due, first, to an inconsistent routine and, secondly, to the fact that this demand has been satisfied, more often than not, by the authorities in charge.

Irregular appetite is due also to inconsistent routine. In addition to this fault, there has also been an insistence upon eating everything that is placed before the child without inquiry into the child's capacity. Many a child is discouraged by the amount of food placed before him. Small helpings easily eaten lead to requests for second helpings. By smaller helpings the aesthetic rules are not violated. There is usually, in these cases, very little attempt made to incorporate the attendant attributes of this appetite by tasty and varying preparation.

Finicky eaters are usually children who have not been allowed to develop full satisfaction in this appetite and must use other means of attracting attention, as compensation. They will refuse an article of diet one day and accept it the next. For a period they will eat only one article of diet, for example, cornflakes, eggs, peanut butter, sandwiches, or will refuse for long periods milk, fresh vegetables, etc.

It is idle to interpret their behavior as contrariness. There is a reason for the development of likes and dislikes. It is interesting, for instance, to note the antagonism developed in certain children against the drinking of milk. Usually these children come from homes where there is an ample supply of food. Usually, too, there is a "milk fetish," viz., the whole nutritional scheme is based on the assumption that milk is a divinely arranged food and without it catastrophe will ensue. The child, quick to evaluate total situations, uses the refusal of milk as his compensatory reaction to this atmosphere. By adopting a sane parental attitude towards diet, this antagonism disappears.

Very frequently in children manifesting this finicky, sometimes called fastidious, behavior there has been *too much* emphasis placed upon individual satisfaction. Substitutes are always at hand for a refused food. The child will refuse a dry cereal and will be given a boiled cereal, will refuse apple sauce and will be given custard, etc. It may seem contradictory to state that if a child refuses a food he should not be given another as a substitute. This procedure seems at variance with the outline stated above that the child should be allowed to develop his individual satisfactions. By placing food, nicely prepared and not too far removed from his usual diet, before a child and then permitting him to choose *whether to eat it or not,* giving no substitutes and making no comments, there is developed, first, an attitude of acceptance without loss of personal prestige and, secondly, an appreciation of tastes and distastes based on a philosophy of accepting the consequence of refusing, viz., to go hungry. Under these circumstances the child growing up to be an adult arrives at maturity with a reasonable repertoire of tastes and not a scheme based upon personality traits borrowed from other realms than the appetite of hunger.

To prove that the problem of children's likes and dislikes is dependent upon the environment and not on the foods themselves, records from any well-organized nursery school may be employed.

At St. George's Nursery School over a period of six months, with a registration of 36 children, there were 7438 separate opportunities for

refusal. Only 103 refusals were recorded and these were confined to the children under three and one-half years of age. Twelve of the children did not refuse a single food.

In Table 2 is shown the list of foods included in the menu over a period of six months, the number of times each was served, and the percentage of refusals. It can be seen that the number of refusals is insignificant even with those foods at the top of the list that are refused most frequently.

The atmosphere of the Nursery School is one of sympathetic though strict discipline. The children are given an interesting diet. They are

TABLE 2

FOODS SERVED AND REFUSED OVER A SIX-MONTHS PERIOD

Foods served	Number of children to whom foods were served	Number of children refusing foods	Number of refusals	Percentage of refusals	Number of times served
Rice	36	7	8	22	2
Casserole of beef and tomato	16	3	3	18	1
Vegetable marrow	57	5	6	10.5	3
Spinach	164	8	14	8.6	8
Liver	41	3	3	7.0	2
Creamed liver	17	1	1	6.0	1
Creamed celery	268	6	14	5.2	13
Squash	23	1	1	4.4	1
Creamed cauliflower	101	3	4	4	5
Creamed fish	256	5	9	3.5	13
Lima beans	99	3	3	3.0	5
Creamy egg	138	3	4	2.9	7
Eggs à la goldenrod	111	2	3	2.7	5
Wax beans	125	3	3	2.4	6
Creamed beef	67	1	1	1.5	3
Liver and bacon	203	3	4	1.5	10
Green beans	308	4	4	1.3	15
Beets	331	3	4	1.2	17
Tomatoes	311	3	3	1.0	15
Potato cubes (in stew)	203	1	1	.5	9
Lamb stewed	224	1	1	.5	10
Peas	230	1	1	.4	11
Carrots and peas	235	1	1	.43	15
Carrots	293	1	1	.34	15
Roast beef	320	1	1	.3	15
Beef steak	326	1	1	.3	17
Mashed potatoes	1820	3	4	.2	88
Foods never refused					
Beef stewed	112	0	0	0	5
Roast lamb	415	0	0	0	20
Bacon	189	0	0	0	9
Creamy egg and bacon	16	0	0	0	1
Creamed chicken	23	0	0	0	1
Cabbage	18	0	0	0	1
Parsnips	43	0	0	0	2
Scalloped potatoes	147	0	0	0	7
Creamed potatoes	42	0	0	0	2

given moderate helpings; they may eat as much or as little as they please. No substitutions are allowed. If they wish to create a scene they are removed from the room. Any home which models its eating routine after this pattern presents few eating problems.

Dawdling at meals is just a variant of this form of behavior. Too much emphasis has been placed on nutrition and too little on the other aspects of feeding.

Children who resist drinking from a cup or feeding themselves are manifesting behavior which follows upon one or two forms of training. (*a*) The attempt to emancipate the child from total dependence has begun too early and too suddenly. The capacity to perform the muscular acts necessary for these achievements depends upon maturity and intelligence as in other learning processes. Also, patience is required in tuition. The child, at first attempts, gets less food for a greater expenditure of energy. A few mouthfuls in a cup and then the regular procedure from bottle or breast is the best initial procedure. Similarly, with fork and spoon the trial must be made by the child but accurate performance must be learned and is perfected only by practice. (*b*) The other mistake in training is to delay the emancipation long beyond the stage at which the learning process itself would have been interesting. The child of two who has never been allowed to feed himself finds the effort uninteresting and unproductive. There is also the satisfaction in the mechanism of dependence upon the mother, nurse, etc. The treatment in this case is, of course, a stated period for the meal, and no assistance given. There is grief for a meal or two but it is soon apparent to the child that he must either fend for himself or go hungry.

There are frequent cases where children refuse all food. They seem to be going on a hunger strike. This seldom happens in a home where there is insufficient food. In the absence of any definite pathological condition it is usually a reaction against bad training methods. It is amazing how quickly these children respond to a change of environment, such as in a hospital under the care of an intelligent nurse. The treatment here is a revision of the total plan of training in conformity with the suggestions made above.

Very frequently it is necessary with some children, because of eczema, food sensitiveness, dislikes, etc., to include or exclude certain articles of diet. Under a satisfactory scheme of training this situation presents no difficulties. The attitude of the nursery-school child or the modern "pediatric" child toward cod-liver oil is ample evidence that any article of diet may be included if presented rationally. The avoidance of foods can also be accomplished if the procedure is not furtive and the permitted diet is so prepared and presented as to satisfy the child.

In conclusion, it may be repeated that the problems that arise in child feeding have seldom specifically to do with the food *per se,* or with the child *per se,* but may be traced in origin to the kind of training program in operation and the expected reaction thereto by the child. The treat-

ment in every case is to arrange for an ideal environment and to try to approximate it.

THIRST

1. *Physiology.* The important aspect of this appetite is that all living organisms live in a fluid medium. The *live* cells of the body are immersed in a fluid and are semi-liquid in structure. The blood, the lymph, the other body fluids bathe continuously the live cells. To maintain this state is one of the imperative functions of organic life and it is not to be trifled with. The importance of this axiom will be appreciated when the social modification is discussed.

2. *Rhythm.* As the actual fluid content of the body tissues is relatively constant, the intake of fluid must be equal to the amount eliminated by evaporation and elimination. The appetitive cycles are similar to those described under "hunger"—a period of restlessness, a period of satisfaction, and a period of quiescence. The rhythm, however, is not as regular as in hunger because external conditions of climate, the effort expended by the individual, and the function of skin, lungs, and kidneys may materially alter the temporal relations of the three phases of the rhythm.

3. *Conscious Aspect.* During the restless phase there seems to be a localized sensory experience which depends upon a condition arising in a relatively circumscribed area of mucous membrane in the posterior wall of the pharynx. This tissue acts as a governor. When there is a bodily need for fluid this area becomes active and gives rise to a conscious experience that later on is to be identified as "thirst." By bathing this area with fluid, i.e., keeping it moist, the sensation is not experienced, but unless the bodily need is satisfied there will be continuous activity. It is very seldom in our civilization that extreme thirst is experienced. So pressing is the demand that we satisfy the need before the extreme conditions arise.

In the second phase, satisfying the need, there are attendant conscious factors, as were described under "hunger." The modalities of kinaesthesia, touch, and temperature are involved. It is rather interesting to call attention to a phenomenon in connection with the satisfaction of appetitive demands that will be discussed more fully under the other appetites. On a warm day, when one is tired and thirsty and is presented with a long, cool drink of water and begins to drink there is such enjoyment of the total situation that there is difficulty in stopping the drinking until completely satisfied. It is suggested that this behavior is in the nature of an orgasm, a term usually confined to the climactic satisfaction of the appetite of sex. Perhaps, this is another common characteristic of all of the appetites, and may be identified only upon analysis after further research has been done. Although water alone satisfies this appetite, the addition of taste and smell to the perceptual complex may add to the individual enjoyment, e.g., cocoa, coffee, hops.

4. *Innate Response.* The suckling and swallowing response, as in

satisfying hunger, is adequately suited for satisfying this appetitive need, providing fluid is provided. Also, the food of infants is administered in liquid solution so that ample fluid is ingested. The amount of fluid per unit of body weight is carefully regulated in all artificial feedings.

5. *Modification*

a. Maturation. There is very little modification of this response by maturity. The lips, tongue, and cheeks act coordinately from birth on, and this activity remains little altered throughout life.

b. Social control. The imperative nature of the demand of this appetite has already been mentioned. It is rather interesting to note that, perhaps because of the biological urgency of this appetite, society has done very little in the way of control; on the contrary, the supply of water remains one of the few of the human needs which is still free, or relatively so. In passing, it may not be amiss to point out that, if this be the reason for so little social interference, one should examine very carefully those aspects of human behavior in which social interference seems paramount from the point of view of their arbitrary and perhaps unimportant character. If all our laws, customs, and traditions were examined in the light, first, of their biological importance and, secondly, of their contribution to national living, some startling revelations might appear.

Of course, the change from nipple to drinking vessel is demanded as well as in the satisfaction of hunger and the discussion under that heading applies here equally well.

c. Individual enjoyment. When there is so little social control one would expect greater freedom for individual enjoyment without distressing interference. Since there is only *one* way to satisfy this appetite, viz., by ingestion of water, and since water is seldom withheld, the situation is ideal for complete satisfaction.

6. *Maladjustments.* The only problem that presents itself in this connection is that of the difficulties that may arise when weaning the child. The same rules apply as discussed under "hunger."

It is wise even from an early age to include in the routine, between meals, the ingestion of a quantity of water. If this plan is carried through to adult life is serves also as a very good health measure.

Elimination

1. *Physiology.* The functional and structural arrangements for elimination in the higher organisms are rather diverse. The lungs eliminate water and carbon dioxide, the kidneys eliminate water and soluble salts, etc., the lower intestine eliminates insoluble waste products and water, the skin eliminates water, salts in solution, etc., the gall bladder eliminates bile. We mention only the eliminative function of these organs. The controversy as to whether these substances are excretions or secretions need not concern us.

There is very little apparent psychological implication in the normal

functioning of the breathing apparatus, or in the mechanism of perspiration, as they pertain to child training. Both functions are well established shortly after birth and, except in pathological circumstances, are seldom subject to training. The importance of training in breathing, for singing and sports, is apparent, but these learning processes are specific and are not included in a program of child training. Passing mention should be made of the breathing exercises employed in Eastern occult practices; what little is known of them indicates a fruitful field for study.

For this discussion, we shall confine our attention only to those aspects of the eliminative functions which have a direct bearing on social adjustment, viz., elimination of urine from the bladder and elimination of feces from the lower bowel.

The most important aspect, for the psychologist, of this function is the understanding of the action of the sphincters. This action is not a simple opening and closing of the aperture by means of relaxation and contraction but is accomplished by two sets of muscles, one which opens the aperture and the other which closes it. These muscles are under the control of separate neural units, derived from the two divisions of the autonomic nervous system. Thus the opening of the bladder aperture is accomplished by the contraction of the radial muscle fibers which have their origin in a fibrous ring circumscribing the urethral opening and the coincident relaxation of the circular fibers. The closing of the aperture is accomplished by the contraction of the circular fibers and relaxation of the radial musculature. Thus both opening and closing are *active* processes.

The adequate stimulating situation for initiating sphincter opening is pressure within the viscus under its control. The sphincter will then be reflexly opened and when the pressure is sufficiently relieved it will reflexly close. To bring this mechanism under voluntary control is the task of the individual as he matures. The nature and technique of this control will be discussed below. The expulsion of both urine and feces is accomplished largely by the contraction of the abdominal musculature which is called into play upon the opening of the sphincter.

The physiology of renal secretion, or of the constitution of the urine, and of the action of the large intestine or colon is not directly pertinent to this discussion, although the clinician in children's problems should be familiar with this data.

2. *Rhythm*. As in the other appetites there are three phases to be distinguished. First, a period in which the pressure within the viscus is approaching the point at which elimination must take place, a need must be satisfied. The next phase is the phase of satisfaction in which some response must be made, and the third is a period of rest as far as overt behavior is concerned.

The duration of each cycle depends, of course, on the functioning of the whole organism. In the case of the bladder elimination the amount of fluid excreted through the lungs and skin will affect the amount of fluid necessarily excreted by the kidneys. The amount of fluid ingested or

the administration of diuretics will also affect the amount. In the case of the bowel elimination, the amount and form of the food affects the mechanism profoundly. Laxatives shorten the cycle and constipating foods lengthen it. The control of these rhythms is necessary, of course, for adequate social development.

3. *Conscious Aspects.* Whether or not there is a specific sensory modality associated with this appetite is a moot question. However, as in the other appetites there is at least a localizable perceptual experience, whether specific or not, but also an attendant conscious experience which later is to be recognized and named as a desire to eliminate. The most urgent sensory experience is that which accompanies the increasing distention of the bladder. Touch and pain endings in the mucosa are not ordinarily stimulated (assuming these endings to be present), but kinaesthetic and pressure endings are certainly present and stimulated in the bladder wall and encircling peritoneum. There may also be special endings immediately proximate to the sphincters.

There is, however, a definite kinaesthetic sensory experience when the sphincters act. The expulsion of urine or feces is experienced both kinaesthetically and by the sense of touch. The closing of the sphincter is then kinaesthetically experienced followed by the relaxation and release of pressure sensations. There is no evidence to lead one to assume that the actual filling of the bladder or rectum is consciously experienced.

The perception of this whole series of events is exceedingly important because otherwise the achievement of voluntary control would be impossible.

4. *Innate Response.* The child is functionally equipped at birth to satisfy adequately the demands of this appetite. Both sphincters respond reflexly and the individual's needs are satisfactorily met.

5. *Modification of Response*

a. Maturation. The suggestion (commonly assumed) that medulation of the nervous system is not complete at birth may explain the lack of any signs of voluntary control of the eliminative mechanisms during the first few months of life. A period of growth seems to be necessary during which these functions are performed reflexly. There is no apparent indication of any change in the performance during this period of development and, as discussed below, any attempt at training during this period, especially in bladder control, yields disappointing results.

No doubt, the change to the erect posture and the increased activity with the onset of locomotive behavior also affects in some way these functions.

b. Social control. There are two aspects of social control which are evident with respect to this appetite: (*a*) the protection of society as it pertains to sanitation, and (*b*) the social tabus which have been developed, viz., shame, modesty, etc. There is no doubt that this latter aspect is closely associated with the training of the appetite of sex because of the anatomical relationship of the organs, but there is also an aesthetic com-

ponent having to do with the attitude (likes and dislikes) of withdrawal, which is developed towards the sensory consequences of these acts.

In essence, the social demands are that the individual satisfy these needs under such circumstances as will provide for sanitation, privacy, and "decency." Although maturation does modify the response in the direction of less frequency, the three conditions mentioned can be met only by training.

With regard to training in prolonging the interval between acts of micturition, there is to be noted a tendency towards this goal in the first

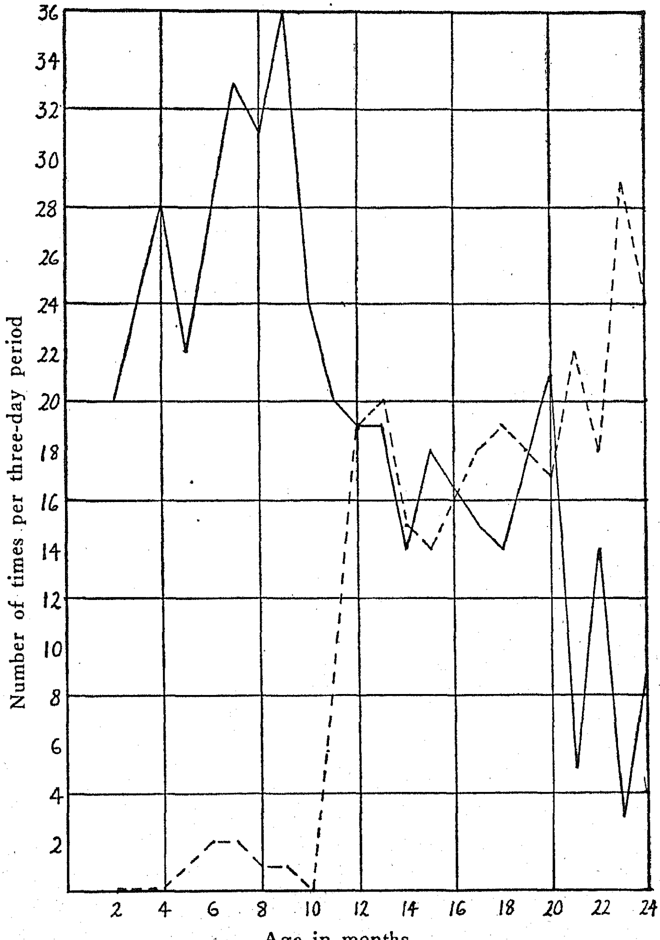

FIGURE 1

BLADDER TRAINING

- - - - - Number of times used toilet
———— Number of times wet clothing

few months of life, but then the frequency remains fairly constant until the end of the second year, as indicated by the initial decline in the solid line and rise in the dotted line in Figure 1. The data which are plotted on this graph were selected from among the children registered at St. George's School. These observations are made in a routine manner on all children admitted to this school. This graph is presented as typical of a child who has been adequately trained, and represents the learning process under suitable learning conditions.

The training proper did not begin until the tenth month when the child was placed on the toilet at regular intervals. The most satisfactory times to choose are those associated with other physiological rhythms, before and after mealtimes and before and after the sleeping or resting periods. The child is placed upon the toilet, and usually the act of micturition commences. No special urging is employed. Explanation at this age is impossible, so that, if after 5 minutes there is no response, the child is removed. When the response has been made and the child is then immediately removed, the association between the posture and the act of micturition is built up and the training is well begun.

By the time the child is twelve to thirteen months old, syllables are vocalized and a simple sound is selected from the child's vocabulary which is enunciated by the parent at the time the child is placed on the chair. When the association is built up, the child will learn to utter this sound when the perceptual experience of pressure within the bladder has been identified. (See above.) At first, it is usually uttered *after* the act has been performed. This is understandable because additional sensory data are included, wetness, coldness, etc. Furthermore, the vocal sound has been associated with the *act* and not with the premonitory symptoms. Thus there will be a period during which the child will, perhaps proudly, announce the act as a *fait accompli* and the parent may wonder why the child should not have anticipated the event. This period is necessary for the child to learn that by recognizing the symptoms early he may avoid the unpleasant consequences of wetness, discomfort, cold, and the consequent necessity of having his clothing changed.

This stage usually occurs about the eighteenth month and from then on the child usually announces his need and if, by vigilance, this need is met the child will learn to keep dry during the daytime by the age of two years. If, however, he should, at times, be interested in other matters the premonitory signals are overlooked until too late and involuntary wetting as an occasional incident persists until the middle of the third year. The routine toilet habits at mealtimes and bedtimes are maintained throughout childhood and become fixed habits of behavior.

Although the child has learned to control his bladder elimination during the daytime, the nighttime, or rather sleeping, control occurs later. Training in this aspect is begun after the first year, usually from the thirteenth to the fifteenth month depending upon his progress in daytime learning. The child is *aroused* from sleep at about 10:00 o'clock and

placed on the toilet. If he has already emptied the bladder prior to this time, he should be aroused earlier until such a time is selected that the child is still dry. The time is then gradually extended until about 11:00 o'clock. Usually by the eighteenth month the child is able to sleep through the night with this one interruption and to control this act of elimination. By the end of the third year this nighttime arousing may be discontinued (summer is the best season for doing this). The child is now adequately trained with respect to this need.

It need not be mentioned that there are great individual differences in the learning capacities of children with respect to this performance as well as others. Some children learn control earlier than others. The ages and stages mentioned above were determined from careful records kept over a period of eight years. Earlier success in training than that mentioned above is gratifying. If control has *not* been established by these times the cases are considered "problems" and will be discussed in the subsequent paragraphs.

With reference to training in bowel control the same general rules apply as mentioned above, but the specific training program is different because of the differing aspects of the two functions.

In so far as elimination of waste products by means of the intestinal canal depends for bulk upon the amount and kind of food ingested, and since this is rather carefully regulated, one would expect this function to be far more regular than bladder elimination, which is affected by climate, effort, water ingestion, etc. Within the first two to four weeks the maturation factor has brought about a condition in which the stools are formed. Training before this stage is not productive of result. When this stage manifests itself training may begin.

As mentioned above, certain times should be chosen which are related to the other physiological rhythms. Consideration should also be given to the ultimate habits to be crystallized for future adjustment. After the first morning feeding and after the evening meal are the most convenient times to choose.

The training consists in emphasizing the normal premonitory sensory experience of defecation. This is best accomplished by the use of a soap stick or glycerine suppository, inserted per rectum. The child is then held on a chamber so that a touch configuration may be experienced. Usually the child responds by emptying the rectum. After a period of two to three weeks' training the suppository is discontinued and the chamber alone used and by the end of the third month regular habits of rectal elimination are established. Usually a child has one or two movements daily.

With changes in diet or in certain intestinal pathological conditions there may occur, sporadically, incidents of soiling the clothes. These must not be considered too seriously as a breakdown in training, but, if prolonged for a time, it may be necessary to initiate a short period of retraining as indicated above.

Under such a regimen the child in due course conforms to the social standards of voluntary control of these eliminative functions. It should be noted that no mention is made of the use of "shame" as an incentive. The modification of the innate response, accomplished by social disapproval of this sort, follows after the initial voluntary control is established. It is not necessary to stress this aspect, as the child will, by the example set in the home, adopt the customs and rules of conduct which he observes about him. After the fifth or sixth year, the necessity for privacy and reticency in public concerning these functions may be mentioned. The inadvertant use of prudishness and undue modesty may elicit behavior of an undesirable character, as will be mentioned below.

c. Individual enjoyment. So completely has social custom, in the guise of "decency," perverted our attitude towards this appetite that the contention that the individual should be trained to enjoy the satisfaction of this need is usually met with expressions of disgust. There is certainly no biological reason for suppressing this potentially pleasurable experience.

As with hunger, if the child is trained to modify his response in conformity with the biological needs alone and the enjoyable factor is eliminated or definitely militated against, then the child must adopt some other means for complete satisfaction. This circumstance gives rise to the many apparently unreasonable behavior patterns frequently associated with this learning process. Perhaps the best training program for parental training in this situation is a reading course in Rabelais.

Cleanliness, privacy, and reticence may be introduced gradually as aspects of the situation tending towards greater enjoyment. In this fashion the child willingly incorporates these factors into the total behavior pattern.

Mention should be made of the orgasmic nature of the satisfaction of this appetite as in the others.

6. *Maladjustments.* The "problems" usually associated with this appetite are of two kinds: (*a*) those cases in which voluntary control has not been established within the usual age limit, e.g., enuresis, soiling, etc., and (*b*) those cases which because of conflicts arising within other aspects of personality development employ unusual eliminative responses as compensatory mechanisms, e.g., retention of feces, sporadic soiling after training has been established, etc.

Although there are wide individual differences, one may arbitrarily state that lack of voluntary control of bladder elimination in the daytime after the second year, and in the nighttime after the third year, may be considered "enuretics." In other words, extra training arrangements must then be instituted. It is, of course, essential that in all such cases a complete physical and laboratory examination be made in order to rule out extraordinary biological or pathological conditions. In some 5 per

cent of cases such conditions are discovered. In the great majority of cases, however, the delay in control may be traced to faulty training methods.

Figure 2 represents a case of a child in which the training program was begun at two months. The training was continued with the result that, at the end of the second year, there was frequency of micturition (cf. Figure 1) and lack of control both night and day. Almost every rule of training was violated in this home, and it was not until the child reached his fifth year that adequate control was established.

The technique for additional training in bladder control is as follows. The educational atmosphere surrounding the child at home must be brought into line with the principles enunciated above, viz., patience, emotional indifference, and restrained vigilance on the part of the parent or nurse. The daytime control is sought first because, before this is established, nighttime control seldom is manifest. The child is then taken to the toilet at regular intervals, in addition to the routine mentioned above. The duration of the interval must be determined empirically. The aim is to find the longest interval over which the child can control

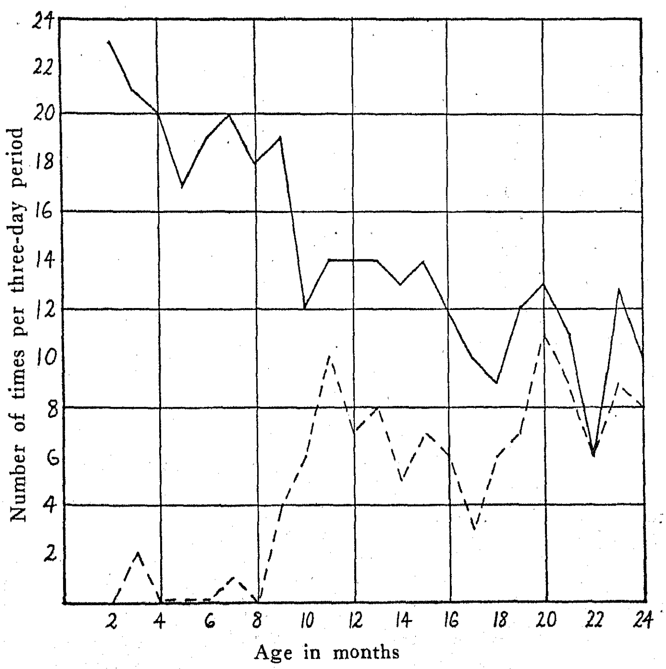

FIGURE 2

BLADDER TRAINING

- - - - - Number of times used toilet

——— Number of times wet clothing

elimination. This is, in the majority of cases, one hour, but in some cases it has been necessary to shorten it to half an hour. Careful records should be kept. If for a period of one week the child has shown control, then the period is gradually lengthened.

When this daytime control is established the same procedure is adopted for the nighttime period. Again the aim is a "dry bed." Empirically the longest interval is determined during which the child can control elimination. Usually the child can accomplish control if aroused three times, at 10:30, 1:30, and 4:30, and taken to the toilet. If, for a week, control is manifested, the intervals are gradually lengthened. The 10:30 period is moved to 11:00 o'clock and kept constant at this point. The 1:30 is moved to 2:00 o'clock; the 4:30, to 5:00 o'clock. Then the 2:00 o'clock time is moved to 2:30 and the 5:00 o'clock time is discontinued. Then the 2:30 hour is moved toward 5:00 o'clock and then discontinued. The 11:30-o'clock arousal time is maintained for a period of six to twelve months and is then discontinued. With incidental and necessary variations, to this procedure, if carefully observed, and if records are kept and parental cooperation is assured, the most obstinate cases of enuresis respond within three to nine months. There is no necessity of using any extraneous form of rewards or prizes and, of course, the corollary to this is that all forms of disapproval should also be avoided. The child is presented with a learning situation, and help and encouragement are given. His accomplishment is his reward. To emphasize his achievement, the child participates in keeping his record under the supervision of the parent or, preferably, both parents.

With reference to bowel control, an arbitrary time limit is again set. If control is not established in six months, after an adequate training program has been employed, then additional routine measures are necessary. The usual problem is that the child will have a movement early in the morning before waking or in the latter part of the midday sleeping period. The procedure is different from that employed in bladder control. The child is not wakened and taken to the toilet. The aim is to establish the habit of adequate elimination during the daytime. Thus the child is put on a routine emptying of the rectum three times daily: after breakfast, after the midday meal, and after the evening meal. Suppositories are used to initiate this routine and especial attention is given to the evening evacuation. Records are carefully kept but, in this instance, as a training procedure for the parent. The child usually responds to this treatment in from four to twelve weeks.

There are children who retain urine and feces an inordinately long time. A great many of these cases are overlooked because obviously they do not cause the type of annoyance evidenced in the above-mentioned cases. In these cases a great deal of stress has been laid on the social and cultural aspects of control. Usually there has been some difficulty in establishing the habit of responding to the chamber situation. One mother stated that

she hated to place her six-months-old girl on the chair because "she hated it so when she was a child."

A careful inquiry into the philosophy of training in such homes will disclose a routine barren of any enjoyment of all the appetites. The child has discovered ways and means of circumventing the familial discipline to his own satisfaction. The treatment is not specific but in the nature of a general revision of the routine in conformity with the principles of a fuller life. There are two cases on record at St. George's Nursery School of children at two years of age (both boys) who would not empty the bladder in the school washroom and retained the urine from 9:00 in the morning till 3:00 in the afternoon. In these cases too much emphasis had been placed upon privacy. By not insisting upon elimination, but rather upon making an attempt, the behavior was brought into conformity with the school routine in a matter of two weeks.

Soiling in children over the age of five, especially at nighttime, is usually a compensatory response to the total situation. A boy of eight manifested sporadic incidents of bed-soiling. The situation upon analysis showed a jealousy reaction towards the boy's stepmother, brought into the home shortly after his own mother's death. Removal to the maternal grandmother's home cleared up this form of response. Obviously, this was only part of the treatment, but it is an illustration of how complex such situations may be and yet how easy it is to think of the symptomatic responses as simple "obstinacy."

Such cases as appear in juvenile court clinics for "malicious damage" consisting of soiling in clubrooms, private dwellings, etc., are beyond the scope of this article. However, it should be observed that, by an analysis of the total appetitive milieu of the case, usually an explanation of the incident emerges and adequate treatment suggests itself.

Rest

1. *Physiology.* All living organisms manifest a definite alternation of activity and rest. In the higher organisms this alternation is clearly discernible. The heart action is an excellent example of this phenomenon. One thinks of the *continuous* action of the heart, but the rest period after each beat is nicely adjusted to permit the heart muscles to perform their function throughout the life-span of the individual. This resting phase is manifest in every organ, indeed in the action of each individual cell. In addition to this unitary resting response, there is a more generalized phenomenon which may tentatively be described as a period during which the individual ceases to react specifically to the environmental milieu. This is not strictly accurate, because the resting response itself is an adjustment to the environment.

It is unnecessary to recapitulate the various theories of rest, whether it be toxic, circulatory, or hormone control, etc., but it must be clearly indicated that so-called fatigue is only *one* of the contributory factors involved in this appetitive demand.

This appetite may be defined physiologically as the need for the organism of a generalized resting period during which overt response to specific environmental situations is suspended.

2. *Rhythm.* The usual three-phase rhythm is present in this appetite. The phase of restlessness is usually rather short, the satisfaction phase during which the child is asleep is rather long, and the third phase of "activity" or "not resting" is rather short. It seems paradoxical to call the third phase of this rhythm the quiescent phase, but it must be recalled, as in the other appetites, that this period is identified as the time during which the individual does not appear to react in any way to the manifestation of the specific appetitive demand in question. With respect to the appetite of rest, the individual during this phase is no doubt *active* but the responses are made under the influence of other appetitive needs and desires.

There does not appear to be any regular rhythm established at birth. Later training will determine the duration and specific times at which the child will respond to his need for rest.

3. *Conscious Aspect.* Again, it is impossible to name, at present, a localized sensory modality through which this appetite is experienced. It has been suggested that there is a neural center which controls the sleeping response and that activity of this center may mediate sensory phenomena. Whether this be true or not, the individual recognizes during the "restless" phase certain configurations which he later interprets as "tiredness" quite distinct from the "fatigue" configuration. There are attendant sensory components such as heavy-liddedness, and mild pain sensations in muscles and joints that are quite pleasant, especially if the opportunity for resting affords itself, but, on the contrary, unpleasant if this prospect is denied. Langor and stupor must have their perceptual origin in some sense complexes.

During the phase of satisfaction it is, of course, impossible to state of what the conscious experience really consists. There is, however, conclusive evidence of the continuity of thought which is no doubt influenced by the perceptual background during sleep.

During the third phase, that of quiescence, the manifestation of alertness, "pep," and energy is influenced by the sensory qualities of this period.

4. *Innate Response.* Sleeping must be regarded as an active and not a passive process. It is no doubt an unlearned response. Whether the child, *in utero,* actually sleeps or not is an undecided question. That he *rests* is indisputable. Soon after birth the child is observed to close his eyes, the eyeballs roll upwards, the limbs are relaxed either in flexion or extension, and the child is said to be asleep. During this period there may be movements of the limbs, the eyes may partially open, the eyeballs move, and yet to all intents and purposes the child is still asleep.

The sleeping act is modified greatly during development, as will be seen, but the act of falling asleep and remaining asleep is no doubt innate.

5. *Modification*

a. Maturation. There is definite evidence of maturation in the

TABLE 3
Hours of Sleep

Age in years	No. of cases	Average amount of day sleep Hrs.—Mins.	Average amount of night sleep Hrs.—Mins.	Average amount total sleep Hrs.—Mins.
1	57	1—45	11—55	13—40
2	59	1—17	11—36	12—53
3	50	1—06	11—23	12—29
4	41	—42	11—19	12—01
5	34	—15	11—34	11—49
6	31	—05	11—13	11—18
7	27	—02	10—52	10—54
8	15		11—07	11—07
9	18		10—41	10—41
10	14		10—26	10—26
11	8		10—09	10—09
12	4		9—52	9—52

gradual decrease in the amount of sleep required by the individual with increasing years. This growth phenomenon may be associated with the change in muscular response, as noted by Koffka (48), which is observed as the infant matures. The exact nature of this maturation factor is not known.

b. Social control. Just as with thirst, which is a biologically urgent appetite, so with sleep, which also expresses an imperative need, social customs interfere very little with the actual satisfaction, but, in so far as the child must be looked after by someone until full responsibility is assumed, the responses must be modified to suit the convenience of these protectors. The training consists largely in regulating the rhythm of this appetite.

As stated above, the rhythm at first is irregular. Infants sleep or rest for about eighteen to twenty hours a day. The actual sleeping time is much less than formerly thought. The infant does not sleep for long periods but interrupts his sleeping period by periods of wakening. These are not always noted because the infant does not necessarily cry during these periods of being awake.

The duration of total sleeping times for children during the first years of life are indicated in Table 3.

During the first month or two of life very little attention is paid to the development of routine sleeping as the child is fed, and changed, and bathed, and the rest of the time is best left alone.

From this time on the waking hours increase in length. The child usually remains awake after the 6:00 o'clock feeding. After 8:00 o'clock the child is bathed and dressed and then sleeps again after the 10:00 o'clock feeding. He sleeps for a time after the 2:00 o'clock feeding and should be encouraged to be awake between 4:00 and 6:00 P.M., which is the time that he, later on, begins his social training. He sleeps after his 6:00 o'clock feeding and it is to be hoped that he continues this rest

period until 6:00 the next morning with the only interruption being the 10:00 o'clock feeding.

When he begins to sit up and, later, to crawl, between the ages of six months to ten months, he should not be put back to bed after the 10:00 o'clock feeding or, later on, after breakfast, but should be placed in a play pen. He will usually fall asleep for a time, but if the pen floor is covered by a blanket he need not be removed to his bed. After he begins to toddle this morning nap is usually discontinued. The sleeping period after the noon meal should be preserved as long as possible. After the age of eighteen months it is not necessary to undress the child for bed but the clothing may be loosened and the shoes removed. The afternoon nap should not be allowed to last longer than an hour after the third year, otherwise it shortens the nighttime sleep.

A child sleeps best in a bed, alone. The surroundings should be constant. No light should be allowed in the room, the door should be closed. There is no necessity to observe any extraordinary rules of quietness in the home in order not to disturb the child's rest. Children familiarize themselves with the ordinary sounds about the household and are not disturbed thereby.

The sleeping habits of later life are laid down in early childhood. There is no more important routine for the child to learn. Consistent adherence to the more or less arbitrary rules, with an infraction only under necessity, is indicated.

Most children desire to take a toy to bed with them and there is no harm in permitting this indulgence. A favorite teddy bear or doll makes the short period of wakefulness more enjoyable and seems to add to the sense of security sometimes impaired when a child is left alone.

The gradual disappearance of the daytime sleep is solely due to the customs of our civilization. The after-lunch siesta is common to many countries. In some progressive schools the older children rest after lunch, and sleep, as well as the younger. It is not amiss to point out that the preservation of this custom into adulthood would be a splendid practice from the mental-hygiene point of view. Of course we would have to modify somewhat our life goals. This custom would be incompatible with modern industrial and economic competitive practices.

Careful observation of sleeping children shows that there is a great deal of movement and restlessness. The extended posture of later life is a learned response and should be encouraged.

c. Individual enjoyment. Too little attention is paid to the opportunity of enhancing the enjoyment of this appetite. The mere fact that in many homes "being sent to bed" is a form of punishment indicates the parental attitude towards this appetitive response. Peace, comfort, and repose are all necessary. The preliminary bedtime period should be happy, free from excitement, and by all means devoid of the daily admonitions. The room should be airy, clean, and familiar. The child should be trained to look upon the bed as his friend and sleep as a desirable state.

5. *Maladjustments.* The "problems" that arise in connection with this appetite can all be traced to faulty training: children who will not sleep, and, later, children who will not go to bed, and, later still, children who will not get up in the morning.

There is no problem in the home where the bedtime is a strict rule, where sleeping has been looked upon as an enjoyable experience, and where the physical surroundings are propitious.

Every case brought to a clinic should be examined in the light of these three aspects.

The most common error in training is to permit the child to put off the sleeping time, even for five minutes. This may be accomplished in a myriad of ways: (*a*) asking to be allowed to stay up, (*b*) asking for a drink of water, (*c*) indicating a need for elimination, (*d*) expressing a fear of being alone, (*e*) some imaginary ailment, and so on, *ad infinitum*. If any any of these latter situations arise they must, of course, be treated with the seriousness that they deserve, but the next night the bedtime is moved forward, and the parent must give ostentatious supervision over all possible contingencies; then the door is closed, and if necessary locked, and all appeals are ignored. Parental courage is all that is needed in these cases.

The child who sleeps little in the afternoon, but rests, is sometimes the cause of worry to parents. In these cases, there is usually the fetish of "need for sleep." If the child does not sleep the prescribed amount, all the irritations of the day are blamed on this fact. No one can say definitely how much sleep a child *requires*. There are no doubt widely individual differences. All that is necessary is that the child should rest. After five years of age, the child may occupy himself during the afternoon rest period with a book or other quiet occupation. To demand sleep is not only unwise but fruitless.

There are no problems of training so easily dealt with and which respond so readily to adequate treatment as those connected with sleeping. A reasonable routine rigidly but patiently enforced is always successful.

Mention should be made of disturbances of sleep by nightmares, somnambulism, etc., but they are dealt with under emotional training and are only vicarious sleeping habits, originating in other aspects of personality development.

Change

1. *Physiology.* The physiological background of this appetite is rather obscure. The human organism is so constituted that there is a demand for a change of attentive adjustment after a given sensory complex has been perceived. What little is known about sensory adaptation applies to this appetite. If a given visual background is attentively observed without movement of the eyes (a very difficult adjustment to maintain), the mixture of complementary visual experiences with the seen field reduces the conscious experience to a neutral gray. It becomes more and

more difficult to maintain the fixed regard; there is a demand for a change of ocular fixation. This is true of all sensory modalities. The rapidity with which one can change one's attentive adjustment depends upon an innate factor and also upon a learned factor. Once an environmental situation has been perceived it loses its power to maintain the attention of the individual and the attention is directed to some other aspect. Or, in other words, once an individual interprets a configuration then he must turn to some other aspect of his world of potential experience.

The psychological aspects of attentive adjustment are concerned with the behavior elicited by this appetitive demand.

2. *Rhythm.* The rhythm of this appetite is very short. There is a period of restlessness, a phase of satisfaction, and a phase of quiescence. At the first the whole rhythm may occupy a few seconds of time; but, as will be shown in the succeeding paragraphs, there is a learning process by which successive rhythms may be unified into a major rhythm lasting over more prolonged time intervals.

3. *Conscious Aspect.* The experience which dominates the restless phase is best named "ennui" or "boredom." It is not a simple sensory experience. It differs from tiredness and fatigue because it may be manifest at times when neither of these latter phenomena is present. The conscious attributes of the response phase may be described under the heading of "curiosity."

4. *Innate Response.* Not only is the individual capable of changing from one aspect of the world to another, but it is an imperative demand. The phenomenon of ambiguous figures, such as the reversible boxes, demonstrates the activity admirably. Providing one is able to envisage the two (or more) aspects of the pyramid of boxes, it is impossible to maintain permanently any *one* aspect. This is a fortunate circumstance, because if this latter performance were possible, the individual would ultimately go into a state of coma, or complete adaptation, from which there could be no recovery.

5. *Modification*

a. Maturation. Although there is no evidence to support the contention, it seems as if there is a fixed innate type of response to the need of satisfying this appetite. The speed with which an infant can perceive a situation and change to a following one is at present undetermined. By means of a tachistoscope it is possible to determine the perceptual speed of an older individual. The quicker this perceptual speed, the more readily may the individual adjust to complicated situations. There is no doubt that this phenomenon is very closely allied to the higher intellectual processes. Whether this phenomenon changes through growth and development is unknown. There is a good deal of evidence that the sensory acuity of an infant is lower than that of an adult. Whether this is a true difference based on biological change or not is open to question.

b. Social control. As with the other appetites, the type of social demands depends upon the mores of the community. "Life is real, life is

earnest" is the tacit philosophy of our civilization. Children must be brought up to have ambition, to strive, to succeed. Since this appetite mediates the interests of the individual, we demand that the child have certain prescribed interests, such as vocational urges, conventional tastes, and standardized loyalties. Our educational philosophy is based upon such hypotheses.

A brief analysis of the development of voluntary attentive adjustment shows that all children are capable of being interested in all things. At first the need for change makes possible the receding of the child's sensory horizon.

The "apperception mass" of the child increases in volume with age. About certain constellations such as food, mother, light, there is gathered an increasing number of aspects to which the child can attend. This systematization of the world about him and within him is an inevitable process. Because the so-called material world is presumably stable, these constellations become crystallized and form the basis upon which the child learns to adjust more or less adequately.

As indicated above, this appetite so regulates behavior that the attention of the individual is continuously directed towards new phases of the world of experience. By "new" is not meant entirely unfamiliar objects, but rather that the immediately-attended-to situation becomes "old" or "boring." A new aspect must follow. In this way the child "analyzes" and hence systematizes his experience, always in terms of his adjustment thereto.

The more potential situations there are associated with any one constellation the longer may the child attend to the ever-changing facets thereof. In this way the type of attentive adjustment commonly called voluntary is developed. As can readily be realized, this process grows upon itself. The more facets there are to a situation the longer the child attends; the longer he attends the greater will be his number of associations, which will permit him to attend the longer, because the chances of being bored, or desiring changes, are less. Thus from birth onwards the child, because of this appetitive demand, is capable of developing interests.

The speed of change-response and the fullness of his perceptual possibilities determine the kind and extent of his interests.

In the course of his development certain interests are socially demanded, e.g., the development of physiological control, the standardization of vocal responses, and later on, reading, writing, and arithmetic.

By bringing pressure to bear upon the individual, *any* type of response within his capacity may be called forth. Unless the child is "interested," this response is stereotyped and accompanied by resistance. On the other hand, if the above reasoning is valid, there are no aspects of potential experience in which the child cannot be interested, *provided* that the situation is so arranged that his interest will grow because of increased "knowledge about" and that each new experience is organized into the adjustment

pattern of the child. This plan is envisaged in the newer philosophies of educational method.

When in later life we divide the activies of an individual into play and work, or vocation and recreation, we tacitly confess that our technique of training has been faulty. What we should envisage is an individual who is busy, not in making money or in winning prizes, etc., but whose every moment is interesting whether he is selling bonds, building roads, lying under a shady tree, or washing his face. The emphasis is placed upon activity and its creative possibilities and not upon the by-products of such activity, such as wages, medals, and trophies.

How is this to be accomplished? By interfering as little as possible with the learning processes of children; by arranging the environment so that the child is presented with new situations; by preventing the child from attempting too difficult or too easy a task; by avoiding all techniques that are intrinsically and unnecessarily boring.

It may be mentioned, in passing, that a child who is interested is also interesting. This also applies to adults.

c. Individual enjoyment. Needless to say, with respect to no other appetite have fewer constructive plans been made to satisfy the individual. Tasks, rules, educational programs, are thrust upon the child, and there is little wonder that he emerges from childhood to assume a standardized, unimaginative, conventional, and, on the whole, an uninteresting adult existence. The few hardy souls who seem to deny this contention are the exceptions that prove the rule. Any clinician will testify to the imaginative sterility of most of their patients over the age of forty. Those whose success towards *one* circumscribed goal may be measured in superlatives give even greater evidence of lack of development in satisfying this need.

6. *Maladjustments.* Laziness, inattention, lack of ambitions, destructiveness—these are the indictments against the children who are brought to the clinic. These indictments are boomerangs, because they immediately impeach those who have had charge of the training. None of these characteristics may be identified in any infant. They are solely the result of an educational plan which ignores the fact that interests must be nurtured and *not* implanted.

A child "loses interest" in tasks which are too difficult, also in those which are too easy. If he is assisted too much in his learning he loses the satisfaction of self-achievement.

The granting of artificial awards for achievement diverts the child from the intrinsic gratification in creative endeavor towards the empty honor of crystallized social approval.

The treatment suggested for such cases as mentioned above is in the direction of rearranging the whole learning background to permit the child to *revive* his interests. Encouragement, inspiration by example, and not by exhortation and patience—if these are manifested by the tutor, whether teacher or parent, the results will always justify the procedure.

Sex

1. *Physiology*. The physiology of the reproductive system is, in principle, relatively simple. The male sperms are formed in the testicles, are stored up, and then ejected through the urethral canal. In the female, eggs are formed in the ovaries and find their way to the uterus. The male organ of ejaculation is so constructed that the sperms may be deposited at the mouth of the uterus, whence, being motile, they find their way up the cervical canal to the uterine cavity. The union of the egg and sperm completes fertilization.

But this is not the whole story. The complexity arises when one considers the enormous influence of the reproductive functioning upon the whole organism. This influence is twofold: (*a*) hormonic, and (*b*) overt behavior.

One might conjecture that the reason for this wider influence is because, in the higher organisms, the two sexes are disparate, and for the preservation of the race it is necessary to arrange for their union. In order to make the union of the two sexes more certain, specific characteristics must be developed which make them mutually attractive. These peculiar qualities are called secondary sex characteristics. They consist in certain embellishments of the individual which will affect favorably the perceptive activity of the opposite sex, e.g., plumage in birds (vision), secretions of the auxiliary sex glands (smell), peculiar tics in voice (audition), erogenous zones (touch), etc. These structural and functional developments are dependent for their appearance upon the hormone secreted in the interstitial tissue of the sex glands of either sex. These hormones also influence the general growth process in such a way as to mold the bodily structure to the type peculiar to each sex.

There is no doubt that these hormones also mediate the personality traits peculiar to either sex—aggressiveness in the male and coyness and submissiveness in the female. These traits, however, may be greatly altered by training.

The sex act itself, which is the consummation of this appetitive need, is divided into two parts. The preliminary or preparatory phase is one of contrectation, wherein the individual is stimulated to prepare for and accept the approaches of the opposite sex. The second phase of the act, detumescence, is where the sperms are ejaculated within the vagina accompanied by a similarly climactic response in the female.

It is unnecessary to describe in detail the physiology of menstruation whereby at regular intervals the uterine cavity is prepared for the reception of a fertilized egg.

2. *Rhythm*. This appetite also exhibits the three-phase rhythm. During the restless phase the individual manifests in his behavior those seeking responses most likely to satisfy his need. The phase of satisfaction is marked by the beginning of contrectation and ends with detumescence; the quiescent phase then follows.

In the lower organisms the female exhibits a rhythm dependent definitely

upon physiological functioning. She is said to be "in heat" when she is receptive to union with the male. Whether the male also manifests a regulated rhythm or not is still a matter of conjecture. In humans any regular rhythm, if present at all, has been cloaked by the training which the individual undergoes. Gynecologists and physiologists have suggested a period during the menstrual cycle at which the female is more receptive than at other times. There is much evidence to support this view, but, again, the influence of training is difficult to evaluate. In the male, there has been no suggestion, at least in our civilization, that a regular rhythm is determined by physiological conditions.

3. *Conscious Aspects.* There is a localized sense experience associated with adequate stimulation of the erogenous zones of the body that is peculiar to the appetite of sex. An erogenous zone may be defined as a locality in which there is erectile tissue. There are other localities commonly called erogenous zones which do not possess erectile tissue. These are strictly adventitious sex zones, dependent for their sex significance upon training: lips, the anus, the lobe of the ear, etc. Any part of the body is a potential erogenous zone.

In addition to the sensory experience identified as sexual, there is no sense modality which may not be employed, in the restless phase and in the preparatory stage of the phase of satisfaction, for the purpose of gratifying this appetitive demand, especially touch and kinaesthesia.

In this appetite the orgasmic nature of the climax of satisfaction is emphasized, but it must be urged that this phenomenon is not confined to this appetite alone.

4. *Innate Response.* From early infancy the erogenous zones of children respond to direct stimulation. Self-manipulation is very common in childhood. In so far as there is a long period of development before the adult sexual response is possible, the innate behavior is masked by the intervening training which the individual undergoes. Observation of lower animals indicates that without tuition the two sexes achieve union and procreation. There is no doubt that this would also be true of human behavior if experimentation were permitted. The ignorance of the average human individual concerning copulation and procreation is not because there is no innate capacity but because there is a definite training program directed, not only toward keeping the individual in ignorance, but also toward preventing learning.

5. *Modification*

a. Maturation. For a fifth of the life-span of the individual the maturing of this appetite in all of its aspects is proceeding. It is a mistake to think of this period as a quiescent or somnolent stage. During these years not only is the appetite subtly manifesting its influence, but the development of personality with respect to tastes, interests, and other cultural aspects is going on. These latter phenomena have a direct bearing upon the later sex behavior, as will be indicated below. The apparently

sudden activity in the anatomical and physiological realms at the age of puberty is more dramatic than the continuous mental and social growth process but it is not more significant.

b. Social control. When one considers the arbitrary nature of the social interference with this appetitive demand one no longer wonders why it should present so many difficulties of adjustment, on the one hand, and, on the other, why this appetite has been given so much emphasis in modern psychiatric thinking.

First, the child is given ample opportunity for experimentation with all the other appetites. This is denied with sex. Secondly, a more or less systematized educational scheme is outlined for all the other appetites. Only rarely is an educational plan followed in sex training. Thirdly, very little restriction has been placed upon the satisfaction of the other appetitive needs at every stage of maturity; with sex there is not only a restriction but an *inhibition* upon satisfaction until legal permission is granted by marriage, quite independently of when maturity has been arrived at, or how long an interval intervenes until satisfaction is granted. Fourthly, the gratification of this appetite, even after legal permission, is restricted to a very circumscribed perceptual content. This analysis must not be interpreted as a criticism of social custom or as a suggestion towards any change therein, but it does point out the reasons for advocating changes in the training of children.

Obviously, we live in a monogamous civilization and chastity before marriage and fidelity after marriage are, under the circumstances, ideal forms of adjustment for the social good. The problem is not, should the social scheme be changed, but, rather how can one best institute a system of training which will adjust the individual satisfactorily to the scheme of life into which he was born and within which he must live.

Following the analysis made above, the suggestions for training may be incorporated under the four headings:

1). In so far as actual experimentation is contra-indicated, there is no harm in permitting the child or youth to enjoy the substitutes, namely, social contact with the opposite sex, dancing, sports, music, and other activities which make possible an acquaintance with a mixed group under conditions approved of and encouraged by social customs. Masturbation in early infancy must be looked upon as an exploratory act and not as an immoral one.

2). No one expects the child to learn without tuition his language, mathematics, politeness, etc. How can one anticipate that, without training, the child upon reaching maturity will conduct himself or herself satisfactorily with regard to sex life? In mathematics the number 2 is called a two, and a vulgar fraction is so named without embarrassment, but so stilted and perverted have we become with regard to sexual data that there is immediate rebellion when one suggests that the child should be taught that the male external organ of reproduction is a penis. There is no other adequate plan than one which exposes the truth in

simple phraseology. The detail and content of the curriculum should be as well adjusted to the comprehension of the child as in any other branch of education.

3). In so far as there is a specific inhibition of sex activity between maturity and marriage, some compensatory activity should be fostered. There is no need for emphasizing the need for such compensation. If there has been adequate training of the appetite of change, the individual finds an infinite variety of outlets for his activity. With no restriction upon the society of the opposite sex, except cultural inclinations, the cultivating of communal interests in this manner is not only satisfying but also affords a splendid milieu in which to make the choice of mate. How much better this plan would be than the present system of mate choosing need not be emphasized.

4). If adequate and complete sex training were instituted and if mates were chosen under auspicious circumstances, the confining of one's sex activity to one person would be not only acceptable but completely satisfying. Van de Velde's *Ideal Marriage* indicates how this marital sex adjustment may be made in conformity with the plan outlined above.

c. Individual enjoyment. Obviously no instruction is given except in the nature of tabus and inhibitions; the gratification of the individual is achieved only through subterfuge. The principle that what is forbidden is thereby enhanced in value applies all too patently to this appetite; on the other hand, so deeply ingrained may be the revulsion and disgust toward sex generated by faulty training that the individual throughout life may derive no personal enjoyment out of satisfying this appetitive need. This circumstance is even more alarming when one considers the influence of this form of behavior upon the partner who contributes to the situation.

6. *Maladjustments.* The common "problems" of childhood with reference to this appetite are masturbation, unusual sex curiosity, and sex practices.

Masturbation, or self-manipulation, is common to all children. There is no reason why the child should not explore his sex organs as he does other parts of the body. If this fact is recognized and no undue emphasis is placed upon this behavior by slapping or scolding, the child will turn to some more interesting aspect of the environment. On the other hand, if he, or she, by restriction and force is prevented from initiating this activity, efforts will be made to accomplish the act. This procedure is usually followed by the persistence of this form of manipulation.

Sex curiosity is as normal an interest as any other. It can be satisfied only by learning about the phenomenon. The answering of all questions truthfully and unemotionally completely satisfies the inquirer; furthermore, it builds up a relationship of mutual confidence and respect between the child and parent which is most desirable. In passing, the parent is the ideal tutor for the child in his sex education. No other agency should be employed except in the case of loss of parent or gross incompetence on the parents' part.

Early sex practices or actual experimentation upon the opposite sex is an indication (*a*) of lack of adequate sex education and (*b*) lack of education in the other appetitive fields, especially change. Children who engage in these practices should not be looked upon as sex delinquents but rather as educational unfortunates.

* * * * *

In conclusion, this chapter is only a summary of the major points of a discussion of the physiological appetites. It is not by any means exhaustive. The scheme as presented may not be ideal but at least it is suggested not only as a means of better understanding of this realm of genetic development, but also as a plan of training which may be used and taught. Further research will, no doubt, evince data which will supplement or alter the scheme somewhat. At present it has been found most useful as a clinical philosophy.

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PART V

STUDIES OF SPECIAL GROUPS

CHAPTER 19

THE GIFTED CHILD*

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TYPES OF GIFTED CHILDREN

We may distinguish two classes of gifted children: (*a*) the intellectually gifted, and (*b*) those with specialized abilities. In the first class we include those who rate high in the tests that are commonly designated as tests of general intelligence. The second includes those whose exceptional gifts are confined to one or more special fields, such as music, art, lightning calculation, chess playing, mechanics, etc.

It is not implied that these two types always stand out clear and distinct from one another. On the contrary, an individual may be highly gifted in both general and special ability. One who is gifted in either way is more likely than the average person to be gifted in the other way also. The distinctions have been made primarily in order to call attention to the fact that superiority of one kind does not *necessarily* imply superiority in everything.

Another chapter of this *Handbook* includes a discussion of specialized abilities. The greater part of our chapter will therefore be devoted to children who are characterized by high intelligence quotients as measured by the best available tests of all-round mental ability. Topics to be covered include the physical, intellectual, and personality traits of such children; their social origin; their development from childhood to maturity; and their scholastic accomplishments in various fields. A short section will be devoted to the educational methods best adapted to enable them to realize their unusual possibilities. We shall consider, also, the contribution of the early development of geniuses to the psychology of the gifted child and the implications found in studies of gifted children for explanations of the nature of genius.

WHOM SHALL WE CALL GIFTED?

What level of talent do we have in mind when we discuss "gifted" children? The designation can be only arbitrary, for the distribution of ability is continuous, not discrete. When large unselected groups are measured upon any variable mental or physical trait the number of cases

*Certain paragraphs of this chapter have also been used by one of the authors in a report on mentally superior children which he prepared for the White House Conference and certain others in the concluding chapter in *Genetic Studies of Genius*, Volume III (13).

becomes increasingly smaller as we go from the mean in the direction of extreme superiority. On a scale of intelligence there is no point of which we can say, except arbitrarily, that above it the children are gifted and below it not gifted. The line might be drawn at IQ 120, 130, 140, 150, or anywhere else in the superior range. For our present purpose, however, it is necessary to draw an arbitrary line; if for no other reason, in order that the reader may know what children we are talking about. If the line should be drawn at 130 IQ, the number of children in the general school population who could satisfy the criterion would be about ten in a thousand, or 1 per cent. When it is drawn at 140 IQ, the number qualifying is about four or five in a thousand (102). About two or three in a thousand test as high as 150 IQ, and less than one in a thousand as high as 160. On the whole, it seems best to draw our arbitrary line at 130 or 140 IQ, and for two reasons. In the first place, children of this grade of superiority are sufficiently unlike average children to need special educational opportunities. In the second place, the most extensive investigations of superior children as a class have concerned themselves for the most part with subjects of this grade of intelligence or above. Unless otherwise stated, the studies summarized in this chapter have as subjects children with IQ's over 135.

Types of Available Studies

Studies of intellectually gifted children are of four main types: (*a*) general descriptive reports, usually by other than psychologists; (*b*) clinical reports on a single case or on a small number of cases, utilizing psychological methods; (*c*) statistical studies based upon psychological and other measurements of groups of subjects; and (*d*) biographical study of the childhood of geniuses.

An example of the first type is the book by Pastor Witte on his gifted son, entitled *The Education of Karl Witte* (118). Young Witte, born in 1800, entered college at nine and received the Ph.D. degree with distinction before the age of fourteen. At sixteen he was given an LL.D. degree and an appointment on the teaching staff of the University of Berlin in the Department of Law. He lived to be 83 years old. Less detailed and less dependable accounts of gifted children have appeared from time to time in books and in various magazines (28). Reports of this kind are always interesting but usually lacking in scientific value, and to present a summary of them here would be unprofitable.

Examples of studies of the second type have been reported by Waddle (111), Leta Hollingworth (53, Chap. IX), Burks, Jensen, and Terman (13), and others (35, 50, 108). Here we find not merely descriptive case histories, but also measurements of numerous physical, intellectual, and personality traits. The results of such a clinical study give a fairly complete picture of the gifted child in terms that are objective and psychologically meaningful. Clinical studies of individual gifted children are extremely valuable and we can never have too many of them when

they are competently done. They do not, however, tell us all we want to know. The case described may be typical or atypical. It is only when data have been secured for a large number of cases selected in such a way as to give representative results that we can arrive at any generalizations regarding what is true of intellectually gifted children as a class.

Moderate-sized groups of superior children have been studied by Leta Hollingworth (53), Root (89), Yates (125), Witty (119), Jones (64), and others (17, 22, 40, 47, 71, 114). The most searching investigations thus far conducted with a large group are those reported in Volume I and Volume III of *Genetic Studies of Genius* (107, 13). As the data of these two volumes give the most comprehensive picture available of the typical gifted child, they will be heavily drawn upon in this chapter. The group studied most intensively consisted of 643 California children of ages two to fourteen whose IQ's were 140 or above on the Stanford-Binet. In addition, extensive data were collected from a high-school group of 378 cases, selected on the basis of teachers' judgments and Terman Group Test scores, and ranging in age from eleven to nineteen years. Since dependable generalizations cannot be drawn from a study of small groups of cases or of cases specially selected, *all* of the brightest children who could be found in a school population of about a quarter-million were included. Sifting of the school population in the search for the gifted group was carried out by a rigidly uniform method.

Biographical studies of the childhood of persons who have accomplished notably in adult life have been carried out by Yoder (126) and by Cox (21). The method is one which yields interesting and instructive results, but it suffers from two serious limitations: The biographical information is always incomplete, and the method tells nothing about intellectually gifted children who did not later achieve eminence.

Composite Portrait of the Gifted Child

Although no one would expect to find gifted children all alike with respect to any physical, mental, or personality trait, or in family background, it is important that we should know how, in general, they compare with children of unselected school populations. This is necessary before we can decide intelligently what kind of educational facilities should be provided for them as a group and what kind of home training may be most advantageous. If gifted children are nearly all puny and sickly, then the important thing is to keep them alive and scrupulously avoid overtaxing them. If they are usually social misfits, then the important thing is to provide social traning with school groups near their own level of social maturity. If they are especially prone to develop psychopathic conditions, then preventive mental hygiene must have first place. If their intellectual superiority is ephemeral and they usually drop back to the level of the average as adult life is approached, then it will be useless to provide for them special educational advantages of any kind. Opinions like these have been very widely held and have done much to delay educational reform

in behalf of the so-called "precocious" child. All kinds of shortcomings have been attributed to them for so long that one sometimes finds a pervading undercurrent of prejudice, even among teachers, against special classes or other adjustments for children of high IQ.

Origin and Family Background. Studies of gifted children show excellent agreement with respect to the occupational and educational status of parents. In the group studied by Terman (107) in California nearly a third of the fathers belonged to the professional classes, a half to the semi-professional or higher business classes, and less than 7 per cent to the semi-skilled or unskilled labor classes. Hollingworth (53), Yates (125), Jones (64), Root (89), and Witty (119) have found occupational distributions quite similar. In the group reported by Goddard (40) the proportion from the professional class was only one-fifth, but his group had a lower boundary, 120 IQ instead of 140, which probably accounts for the difference.

In the California gifted group the average school grade reached both by the fathers and the mothers was the twelfth (107). The parents of Witty's (119) Missouri and Kansas group averaged thirteen years of schooling for fathers and twelve years for mothers. Jones (64) found that 46 per cent of the fathers and 20 per cent of the mothers of her gifted subjects were college graduates. These proportions are higher than the corresponding figures, 24 per cent and 10 per cent, in the California group and may reflect some bias in the selection of subjects.

Certain races and nationalities are almost always found to furnish more than their quota of an "unselected" gifted group, while others—particularly South European, Mexican, and Negro stocks—are lightly represented. The rank-order contribution of the different nationalities ordinarily corresponds closely to the rank order of average IQ's by nationality among the children in a general school population. Jewish children and children of English, Scotch, and German ancestry have a high incidence (107, 17, 40, 64, 53, 119).

Though gifted children occasionally occur in families of mediocre attainments, this is exceptional. In the California study, eminent relatives were extremely numerous. Eighty-two families yielded two or more subjects, which is about 1200 times as many as would occur by the laws of chance (107). Siblings of gifted children, instead of varying about an average IQ of 100 as do unselected children, vary around an average of between 120 and 130 IQ and include a high proportion who are themselves gifted (18, 13).

Sex Ratio. When gifted subjects are located by objective methods of selection, more boys than girls are almost invariably found. The ratio of gifted boys to gifted girls increases with age, being about 7 to 6 for pupils in the elementary grades, and approximately 2 to 1 in the high school. Representative data have been collected in Table 1. The excess of boys may be due to greater variability of the male sex and (in later ages) to earlier cessation of mental growth in the girls. In the case

TABLE 1
SEX RATIOS IN GROUPS OF HIGH INTELLIGENCE

Investigator	Group studied	Ratio of boys to girls
Yates, 1922	25 gifted high-school seniors (above 96 percentile) in California	150:100
Book, 1922	Large group of gifted high-school seniors in Indiana (approx.)	200:100
Colvin and MacPhail, 1924	Top 2% of high-school seniors in Massachusetts	190:100
Jones, 1925	120 children above 140 IQ, ages 3-14, in Pennsylvania	135:100
Terman, 1925	643 California children under 14, IQ's above 140	121:100
	70 of these above 165 IQ	126:100
	378 gifted high-school pupils in California	212:100
Goddard, 1928	244 pupils above 120 IQ in Cleveland special classes	109:100
Witty, 1930	100 Kansas elementary-school pupils above 140 IQ	104:100

of the two studies in which sex ratios differ greatly from those found in the remainder, one (Goddard) has subjects less highly selected; the other (Witty) does not describe the method of selection of subjects.

Physique and Health. Although much overlapping is found when gifted children are compared with unselected children in size, strength, neuromuscular skill, and physical well-being, such differences as occur tend to favor the gifted. Terman's group of gifted children of elementary-school age were found by Baldwin to average an inch to an inch and a half taller than unselected California children of corresponding ages (107). The averages for the gifted group also exceeded the norms significantly for weight, nutrition, breathing capacity, strength of grip, arm span, width of shoulders, and width of hips.

Hollingworth and Taylor's (59) study of Jewish children in New York showed the mean stature of the gifted to be 1.7 inches above that of an average group, and 3.3 inches above that of a feebleminded group. Hollingworth's gifted groups, like the group studied in California, were above normal in weight and strength of grip (59, 78). They were also superior in tests of neuromuscular capacity, including rate of tapping (58) and jumping (78). While they were not quite equal to the average for a control group in "chinning," this fact is attributed by the experimenter to the average excess of seven pounds in the weight of the gifted.

The investigation in California is the only extensive study of gifted children in which thorough medical examinations were given. In addition to a one-hour examination by a pediatrician, health histories were secured from parents and school. Premature births occurred in 4.4 per

cent of the cases. In only 7.8 per cent of cases was the mother's health during pregnancy rated as "poor" or "very poor." The mean birth-weight was approximately three-fourths of a pound above normal, and health during the first year was reported as "excellent" or "good" by the mothers of 74 per cent of the children. Walking, talking, and dentition were slightly precocious, especially talking. Comparison of the gifted with a control group recruited from the same schools showed relatively fewer gifted than control children with poor nutrition, mouth-breathing, defective hearing, headaches, stuttering, or symptoms of nervousness. The daily hours of sleep of children in the gifted group was somewhat above average, and amounted to an excess of about 50 minutes by age twelve. Pubescence tended to be a little earlier in the gifted group than in a random group (107).

In no study of a group of gifted children objectively selected has any support been found for the popular notion that the gifted child is typically one who is undernourished and sickly and whose mental development has taken place at the expense of his body. Other investigators have confirmed the studies just summarized at all the points where similar data have been secured by comparable techniques (17, 64, 119, 125).

Educational Accomplishment. About seven out of eight of the California gifted children were found to be accelerated in school progress and practically none were retarded (107). Even so, a large majority are usually found in school grades far below those corresponding to their mental development, for the average acceleration is likely to be only 14 per cent (Terman) or 16 per cent (Witty) of the age of the child, whereas the corresponding mental acceleration averages about 50 per cent. The average age at the completion of the eighth grade is 13-1 for the boys and 12-8 for the girls (13).

Stanford Achievement Tests administered to Terman's California group and to Witty's Missouri and Kansas group showed that a majority of the children had already mastered the subject-matter from one to three grades above that in which they were located. Studies are consistent in showing the academic achievement of gifted children to be far in excess of the norms as measured both by tests and by school grades. Moreover, superiority is greater for the children in the higher IQ ranges. Hollingworth and Cobb (56), in comparing achievement tests of children clustering around 165 IQ with those clustering around 145 IQ, demonstrated that the brighter group excelled in achievement even though "special opportunity was equalized for these two groups." The advantage of the brighter over the other group was most marked in the tests involving the more complex abilities.

Although the attainment of gifted children is so superior that their school marks and the teachers' ratings of their ability in most school subjects are very high indeed (107, 13, 119), attainment is usually somewhat below capacity as judged by mental age. This may be partly because the children are held back in school grades with pupils whose rate of mental

and educational growth is slower than their own. In the following tabulation, results from representative studies of the educational subject quotients of gifted children are shown. Although the "EQ" technique does not yield strictly comparable results from test to test, it has been used in the great majority of studies of gifted children. It suffices at least for rough comparisons of achievement in the various subjects, and for fairly accurate comparisons of the achievement in given subjects of large groups. The summarized data in Table 2 are all based upon the Stanford Achievement Test.

In reading and in language usage, the average disparity between IQ and subject quotient appears to be nil, probably because gifted children are such omniverous readers. Scores in tests involving informational content which is obtained to considerable extent outside of school are also high (science, language and literature, and the arts in the Terman study). Scores on other academic subjects, however, tend to be less distinguished (arithmetic, nature study and science, history and literature, spelling). The results reported by Gray and Hollingworth are higher than those reported by other investigators.

In subjects correlating little with intelligence but requiring a specialized assortment of abilities, it would not be expected that the "achievement quotient" should equal or approach the intelligence quotient. Hollingworth and Cobb (56) found gifted children to test only average on a penmanship scale. On the Seashore music tests a group of gifted children did not exceed the norms for pitch, intensity, or consonance, but earned a slightly superior average in the test of rhythm (52). In such elementary-school subjects as physical education, manual training, and painting, the performance of gifted children has been rated by their teachers as little superior to the average (107).

Gifted children, however, do not tend as a class to be one-sided in ability, at least not to the extent of having their high achievement in certain fields "compensated" by correspondingly poor achievement in others. DeVoss (27) has shown that there may be a little more individual disparity among gifted than among average children in achievement test scores in the various school subjects. Nevertheless, it is almost unknown for a gifted child to score below the norm for his age in any academic subject (107, 19, 42). There are, of course, cases of gifted children who are deficient in certain subjects involving motor or sensory skills. However, they are so despite their mental acceleration, not because of it, since such skills bear slight relationship to intelligence. There are also cases of gifted children who through special ability, interest, and application in such fields as music or art have far surpassed in a single direction their own characteristic level of achievement, though seldom at the expense of normal all-round growth.

School subjects rated by gifted children as easiest and most liked are those which may be described as predominantly abstract, such as reading and literature, debating, ancient history, etc. These are the subjects

TABLE 2

ACHIEVEMENT QUOTIENTS OF GIFTED CHILDREN ON STANDARD TESTS

Investigation	IQ	Composite score	Reading	Arithmetic	Natural science	History & literature	Language	Spelling	Science information	Language & literature	History & civics	The arts
Patrick, 1924; 25 special-class children over 130 IQ in elementary grades.*	142	133	143	139	129	139	141	124				
Cobb and Taylor, 1924; 52 special-class children over 135 IQ in elementary grades.*	152	146										
Terman, 1925; approximately 300 boys and 250 girls over 140 IQ, ages 6 to 14.† (Boys)	151		145	138			146	140	151	157	148	154
(Girls)	151		145	136			148	138	142	152	138	153
Witty, 1930; 100 children over 140 IQ in elementary grades.†	152	136	143	134	137	132		131				
Gray and Hollingworth 1931; 36 children over 134 IQ in elementary grades;†	151	150	152	153	145	152	149	149				
56 special-class children over 137 IQ in elementary grades.†	157	153	152	156	144	156	148	154				
Herschberger, 1932; approximately 60 special-class gifted pupils completing 6th grade.*	136	132										
Approximately 60 gifted pupils in regular classes completing 6th grade.*	136	131										

*Medians reported
†Means reported

which average children find hardest and like least (107, 125, 10). Curiously, there was little difference in the reported ease and liking of arithmetic between the elementary-school gifted and control groups in California. Both groups placed arithmetic far down the list of rated school subjects, although the pupils of the gifted high-school group studied by Terman showed a greater preference for mathematics (algebra and geometry) than for any other subject (107).

In the California gifted group 45 per cent learned to read before attending school, in Witty's group, 38 per cent. One child studied by Terman (IQ 140, 142, 139, at various testings) may well hold the world's record for early reading. As early as twenty-one months she read and apprehended simple sentences; by twenty-six months her reading vocabulary was more than seven hundred words (4). (See also reference 13, pp. 248-252, for an account of the later development of this child.) Gifted children frequently learn to read with little or no formal instruction.

Special Interests. The quality and quantity of gifted children's reading is far above normal. A two-months reading record kept by children in the California gifted and control groups showed that the typical gifted child of seven reads more books than do unselected children at any age up to fifteen. At nine the number of books read was three times the normal (107). The general excellence of the books read meets corroboration in other studies. Cleveland found that the favorite books were of superior quality in the case of 49 per cent of gifted children (over 120 IQ) but only 9 per cent of a control group (17).

Gifted children have more hobbies and enthusiasms than average children. They make more and larger collections, especially collections of a scientific or historical character (107). Their vocational ambitions tend to be somewhat higher than those of average children, though a small proportion look forward to and subsequently enter occupations which hardly challenge their full capacity, such as stenography, clerical work, mechanical trades, etc. (107, 13, 119).

A test of play knowledge showed that the typical gifted child of ten knows more about plays and games than the average child of thirteen. Gifted children rate their liking for games and their fondness for playing with others as high as do average children, although they spend slightly less time in group play than average, probably because they are so interested in reading. Nevertheless, they spend more time in play than in reading and home study combined (107, 23). Such slight differences as are found in the play interests of gifted and average children tend to be of the following kind:

Play interests of the gifted children are more mature. Interest in certain games and pastimes waxes and wanes a year or two earlier with gifted than with average children. Nearly a third of gifted children prefer playmates older than themselves (107, 119).

Gifted boys more often prefer games and sports that are "typically

boyish" than average boys do. Gifted girls a little less often than average girls prefer amusements that are "typically girlish" (107).

The preferred games of the gifted are more frequently intellectual, and hence sedentary and non-competitive, although the games *played oftenest and enjoyed most* by gifted children as well as by average children are social, active games (107). In general, so similar are the typical play interests of gifted and average children that Lehman and Witty concluded that "no conspicuous differences" exist with respect to types of activities consuming the greatest amount of time if the activities involving reading are struck from the list (75).

Application of Wyman's test of intellectual, social, and activity interests showed Terman's gifted group to rate very high in the first two, and a little above average in activity interests. In intellectual interests the gifted surpassed the control by about 1.4 times the *S.D.* of the latter; in social interests by about 1 *S.D.* (107).

Character and Personality Traits. On such tests of personality as the Cady-Raubenheimer battery, gifted children have obtained scores far superior to those of unselected children in freedom from objectionable interests and objectionable social ideals, in freedom from boastfulness, and in trustworthiness in the face of temptation to cheat. Upon seven separate tests of this battery, from 60 to 80 per cent of Terman's gifted group equalled or exceeded the mean of a control group. In all-round character development the typical gifted child of nine had reached the norm for age fourteen. The Woodworth-Cady test of psychopathic tendencies showed both sexes of gifted children to be about 0.5 *S.D.* above the norm with respect to emotional stability (107). Witty, administering three of the Cady-Raubenheimer tests, also found his gifted group superior (119).

Results of personality tests have been confirmed and extended by trait ratings secured from parents and teachers of gifted children. Teachers report their classroom attitudes to be most desirable. They are responsive to discipline (107, 119), respect school authority (124), and volunteer in class discussions (22). Johnson's (63) report upon questionnaires filled out by thirty-one teachers in St. Paul indicated that classes composed of gifted children were more inquisitive, imaginative, courteous, cooperative, and willing to take suggestions. The children had a keener sense of humor, and they were not domineering, self-willed, egotistical, or easily discouraged. Teachers and parents alike rate gifted children superior upon truthfulness, conscientiousness, perseverence, generosity and unselfishness, and sympathy and tenderness (107, 124).

Even in leadership and social adaptability, traits in which gifted children are commonly thought to be especially deficient, most studies show gifted children to be somewhat superior to children of the general school population. With teachers' ratings of the California gifted and control pupils there was little difference in "fondness for large groups" or in "popularity," about 56 per cent of the gifted being rated above the control mean on the latter trait. However, 67 per cent of the gifted boys and 73 per

cent of the gifted girls were rated above the control mean on leadership (107). Witty (119) found that while gifted and control children participate in about the same number of school activities, special recognition was won somewhat more frequently by the gifted. In Yates's (125) group of gifted high-school seniors, 28 per cent showed "genuine ability" as leaders, whereas only 12 per cent of her control group were "equally prominent." Gifted seniors in high school studied by Finch and Carroll (31*a*) had held twice as many elective offices during their high-school careers as had an equal number of seniors of average intelligence. The gifted pupils studied by Herschberger (47) in Pasadena participated more frequently than children of average IQ in school clubs and in literary and dramatic activities, and held more offices. Only one study presents conclusions which appear contradictory; this study is anecdotal and based upon a small number of subjects in a private school (38).

Does the Picture Change with Increasing Age?

Before drawing any conclusions as to the significance of these findings for the education of gifted children, it is necessary to ask whether the characteristics as above described are lost as maturity approaches. In order to answer this question an elaborate follow-up study of the California gifted group was conducted seven years after the original study had been made (13). It was found that, on the average, the intelligence quotients of the boys showed no tendency to deteriorate, negative changes being balanced by positive changes, but the intelligence quotients of the girls had decreased on the average by about ten points. As a similar sex difference was found in the scores on four different intelligence tests and also, though to a somewhat less degree, in the composite score of extensive batteries of achievement tests in the school subjects, it is probably real. It is possible that gifted girls reach the limit of mental growth a little earlier than gifted boys. The difference, however, is not great enough to prevent the girls from excelling the boys in class marks in almost every subject.

The later school record of both sexes is extraordinarily good. Failures in high-school subjects are practically unknown, more than half the marks earned being of "A" grade. Only one high-school senior in ten rates as high on the Iowa High School Content Examination as the average gifted senior, and the latter is usually two years younger. There is practically no elimination below high-school graduation, and between 80 and 90 per cent of the high-school graduates go to college. In college, because of more severe competition, the marks earned drop somewhat below the earlier high record, but still greatly exceed the norm. Members of the gifted group in college earn far more than their proportionate share of scholarships, fellowships, and student offices, and three times their share of graduation honors.

Several of the older members of the group have taken advanced degrees and a few have already won considerable professional recognition. One is

an internationally known musical composer. One is a nationally known scientist. One graduated from university at sixteen and one at seventeen. At least seven composed, before the age of sixteen, poems that compare favorably with the best juvenilia produced by the eminent poets at corresponding ages. One of the seven is among the most prolific juvenile authors on record, much of her work being of high merit.

The tests of personality traits also gave as satisfactory results as seven years earlier. The group still ranked high in the Woodworth-Cady test of emotional stability and in tests of intellectual and social interests. Tests of social intelligence, fairmindedness, occupational interests, and mental masculinity-femininity were administered which had not been given at the time of the earlier study. In social intelligence and fair-mindedness the group tested far above the age norms. In mental masculinity the gifted boys averaged at the norm for their sex, but the gifted girls were distinctly more masculine than unselected girls of the same age. The occupational interest test gave results similar, on the whole, to those found for superior university students, but with more evidence of interest in the sciences. The Zyve Test of Scientific Aptitude and the Burch Test of Literary Comprehension yielded exceptionally high mean scores.

In health and physical development the gifted children appeared to be holding their own; 84 per cent of the boys and 90 per cent of the girls were reported to be in good health, and only 1 per cent of each sex to be in poor health. Colds, headaches, and "tendency to worry" were no more frequent than previously. Nervousness was less frequent than before among the boys, though a little more frequent in the girls, possibly as a concomitant of adolescence.

Results from other investigators who have followed up small groups of gifted children are in general accord with those outlined. Superior scholastic records in high school were found in the gifted groups followed by Specht (96), Cleveland (17), Danielson (*24a*), Witty (119), and Herschberger (47). Intelligence quotients on the basis of the Terman Group Test averaged 136 in the case of fifty children of Witty's group (119). The disparity between this value and the average IQ, 153, secured five years previously on the Stanford-Binet can be ascribed partly to a difference in the functions measured by the two tests. In Lamson's (71) follow-up of fifty-six gifted children of mean CA 15-0 located in senior high schools of New York City, all had Army Alpha scores within the top decile of high-school freshmen and within the top 7.5 per cent of adults. Educational plans included college in the case of 87.5 per cent of Lamson's group.

Studies by Lamson (71), Witty (119), and Herschberger (47) show that gifted children continue to exert leadership and to participate with unusual enthusiasm in activities both in and out of school. Personality traits are superior according to teachers' ratings (13, 71, 47). There is no noticeable tendency for health to deteriorate (119). Hollingworth (55), measuring forty-seven gifted Jewish children annually for seven

years, concluded that "the intellectually gifted maintain . . . the comparatively greater stature that typifies them in childhood."

So much for the general characteristics of gifted children as a class. Those found for the group thus far studied will no doubt be found for any gifted group selected from the school population of any city or country by means of any of the better forms of intelligence tests when the criterion for admission to the group is set in the neighborhood of 140 IQ. There is every reason to believe that they will be found valid, though in somewhat less degree, for children in the IQ range of 120 to 140. The factual data these studies have furnished should dispose forever of the superstitious beliefs so commonly held regarding intellectually superior children. It is simply not true that such children are especially prone to be sickly, overspecialized in their abilities or interests, emotionally unstable, socially unadaptable, psychotic, and morally undependable, or that they usually deteriorate to the level of mediocrity as adult life is approached. Educational reforms in the direction of special classes, special curricula, and special classroom procedures can now be confidently formulated upon this foundation of established fact. If special classes and special procedures are to be opposed, it must henceforth be upon other grounds than those which have been most commonly alleged.

Deviations from the Central Tendencies of the Group

The composite portrait method is useful, just as concepts and generalizations are useful in the shorthand of thinking. Nevertheless, the composite portrait, like any other kind of average, has its limitations. In telling so much about what is true of a group, it fails to convey any sense of the uniqueness that is to be found in each of those who compose the group. In the present instance, too exclusive concentration of attention upon what is true in general hinders us from recognizing the variety of trait combinations that the fact of personality necessarily implies, and obscures all those characteristics which are exceptions to the rule.

For example, it is true that gifted subjects as a group have held their own intellectually, but it is no less true that some of them change significantly in their intelligence ratings. Making due allowances for complicating factors in measuring IQ constancy, one can hardly avoid the conclusion that there are individual children in the California gifted group who have shown very marked changes in IQ. Some of these changes have been in the direction of IQ increase; somewhat more of them in the direction of decrease. The important fact which seems to have been definitely established is that there sometimes occur genuine changes in the rate of intellectual growth of gifted children which cannot be accounted for on the basis of general health, educational opportunity, or other environmental influences.

Gifted children show large variability in non-intellectual traits. One finds among the subjects extreme deviation from the group average in every physical, mental, and personality trait: in size, strength, athletic

ability, health, scientific ability, artistic ability, literary ability, mental masculinity and femininity, fair-mindedness, social and activity interests, vocational interest, social intelligence, leadership, interest in school work, ambition, and moral dependability. Two members of Terman's group became definitely psychopathic, one committed suicide, and one was committed to a state reform school after an extended career as a delinquent. The group in fact contains disharmonic personalities of almost every type. Several cases of these have been described in Volume III of *Genetic Studies of Genius*. Other behavior and adjustment problems include cases showing inferiority complexes, inordinate conceit, "wildness," disobedience, untruthfulness, social deficiency, dishonesty, and extreme laziness. There are several cases of marked inversion with respect to mental masculinity and femininity, though it must be said that the significance of such inversion is not yet fully understood. A considerable number of the subjects were so lacking in ambition, or in ability to work consistently toward even a moderately distant goal, that after leaving school they either remained content with inconsequential positions or drifted aimlessly from job to job.

The other side of the story would take longer to tell, because there are so many more instances of extreme deviation in the direction of personality balance, stability of character, and successful accomplishment. Many examples could be given of heroic self-sacrifice and of courageous struggle against such handicaps as ill health, poverty, parental ignorance, race prejudice, and other unfavorable circumstances of environment. The numerous case studies included in the follow-up investigation were selected so as to represent almost all of the interesting types one finds among a thousand gifted children, but with a somewhat disproportionate share of the space given to cases that are exceptions to the rule in one way or another. No amount of generalizing from averages can take the place of such case studies, for the gifted child, like any other child, is a real individual with all the possibilities that this implies in the way of personality traits.

Evidence of Latent Potentialities

Many indications were found that a group of gifted children like the one we have described possesses many potentialities which will never be realized. For example, the seven subjects in the California group who had produced the most meritorious literary juvenilia were all girls (13). In view of the preponderance of men over women among the great literary geniuses of history, it is unreasonable to suppose that the group in question does not contain as many boys as girls who have very exceptional literary gifts. The obvious explanation is that in these days boys have so many more interesting things to turn to than do girls, and that the writing of poetry has less prestige value among boys than it has among girls. The group probably contains children of both sexes whose natural literary gifts compare favorably with those of authors who have attained a secure

place in literature, but whether these children will make the most of their native abilities only time can tell.

Again, from the Zyve Test of Scientific Aptitude it appears that there are gifted potential scientists in the group who will never study science. It is probable that the group contains hidden talents of correspondingly superior grade in music, art, mathematics, language, engineering, social leadership, and other fields of human endeavor. There are so many things that go to determine whether superior talent in a given line will result in superior achievement. A child may have many talents, but the complexity of present-day civilization is so great that in most cases only one or two of them can be fully realized even under the most favorable circumstances. And circumstances are not always favorable. Ill health, poverty, unwise educational guidance, accidental personal contacts, unhappy home life, unfortunate love affairs, parent fixations, lack of ambition, and personality defects are factors which, operating in combination or even singly, may prevent the fruition of the most exceptional talent. The world's supply of genius is probably many times as great as one would judge it to be from the amount which comes to light. The supply itself is the product of heredity—a gift of nature which no amount of nurture can substitute for; but whether the raw material furnished by heredity ever realizes its potentialities depends upon nurture factors over which, theoretically at least, man has control. The discovery and cultivation of hidden talents and genius thus becomes one of the most important functions of organized society.

The greater the intellectual gifts of a given child, the more difficult is the problem of making the most of these gifts. In some respects it is to be regretted that exceptionally superior intellectual endowment shows itself so early; that is, is accompanied by such extreme precocity in mental development. The difficulty in the situation arises from the fact that precocity unavoidably complicates the problem of social adjustment. The child of eight years with a mentality of twelve or fourteen is faced with a situation almost inconceivably difficult. In order to adjust normally such a child has to have an exceptionally well-balanced personality and to be well nigh a social genius. The higher the IQ, the more acute the problem. It is therefore especially noteworthy that so few cases of extreme maladjustment have been found. Because of personality defects, however, one now and then finds gifted children who appear to have deteriorated in ability but who on retest are found not to have done so. Usually they are children whose school accomplishment or social adaptability suffers because of personality defects. The intelligence score remains high, but the subject is lazy, lacks ambition, is emotionally unstable, is not well adjusted to his school environment, or is cultivating interests remote from his school work. Not a few gifted children, after making a brilliant record in high school, deliberately decide, when they enter college, to cultivate other interests and so go out for athletics, school politics, feminine society, or anything that will rescue them from the odium of reputation for brilliance.

The average teacher, however, does not discriminate in his judgment of such students and classes them together as examples of intellectual deterioration. The frequent failure of intellectually gifted individuals to develop to the limit of their capabilities is a potent argument in favor of special educational programs for such children.

The Early Mental Development of Historic Geniuses

The investigations of historic geniuses offer many interesting parallels to the study of living children selected on the basis of high intelligence quotient. The subject was opened to science by the epoch-making work of Francis Galton (34), in 1869, whose findings have been in the main confirmed by the researches of Ellis (31), Cattell (16), Castle (15), and others. These authors, however, gave but little systematic attention to the childhood characteristics of individuals who later achieved eminence. Lombroso long ago popularized the belief that many geniuses were as children exceptionally backward and unpromising. Ellis and others, however, have presented evidence to show that a large proportion were characterized by extreme intellectual precocity. It remained for the extensive research of Catharine Cox (21) to establish beyond doubt the falsity of the Lombrosian theory. Her investigation dealt with the childhood traits of three hundred of the most eminent geniuses born since 1450, selected on an objective basis. With the help of assistants trained in child psychology, she assembled from several thousand biographical references all the information which could be found that threw any light on the heredity, health, education, intellectual development, and early personality traits of these three hundred subjects. Particular attention was given to evidence bearing on the course of mental development, such as age of learning to read, age at which given school grades were reached, types of books which were read at given ages, school honors won, reputation for intelligence among school fellows, quality of letters, compositions, and poems that have been preserved, indications as to direction and intensity of interests, etc.

The material so collected was next analyzed and evaluated independently by three psychologists whose training and experience had given them exceptional familiarity with the norms of accomplishment and behavior for the various age levels of childhood. On the basis of the evidence available, each of the three psychologists estimated for each subject the lowest childhood IQ that would have been necessary to account for the facts given. The average of the three judgments was taken as the final (minimum) IQ estimate of a subject. While the resulting data cannot be regarded as comparable in reliability with results of actual mental tests, they represent the nearest approximation to the facts that it is possible to secure. The fact that in the large majority of cases there was fairly close agreement among the three psychologists who made the estimates is evidence of the validity of the method.

It appears that the average (minimum) IQ of the group was not less

than 160 IQ, and that probably few cases were below 140 IQ. The very geniuses mentioned by Lombroso and others as notable for lack of early promise were without exception found to have given evidence of high IQ's during childhood. Among these were Lord Byron, Sir Walter Scott, and Charles Darwin, with estimated minimum IQ's of 150, 150, and 135, respectively. Among those rated above 180 IQ were Goethe, John Stuart Mill, Leibnitz, Macaulay, Pascal, and Grotius.

The childhood traits of this group of geniuses resemble closely the traits of gifted children studied in recent years. However, the average true IQ of the genius group was undoubtedly higher and the genius group almost certainly possessed on the average a more favorable combination of personality traits, particularly initiative, perseverance, and intellectual zeal, since without these supporting qualities even high intellectual gifts may fail of fruition. Other respects in which the data for the geniuses and for the gifted children run closely parallel include the following: the infrequency in both groups of such traits as "queerness," emotional instability, one-sidedness, and lack of social adaptability; the presence in each group of individuals whose superficial traits cause them to be grossly misunderstood; lack of evidence that the intellectual superiority in either group was primarily the result of forced culture; evidence that the direction of later achievement is likely to be foreshadowed by early preoccupation of interest.

Children of Superior Special Ability

It is well known that ability in music, mechanics, drawing, arithmetical computation, and rote memory is not perfectly correlated with general intelligence. In the case of each of these abilities it is possible to find subjects of inferior general intelligence who can perform incomparably better than the average person. Of the numerous cases of lightning calculators who have been studied by psychologists, some had high general intelligence and superior mathematical gifts, while others belonged to the moron grade of mental deficiency. The same is true of those capable of prodigious feats of memory. There is no case on record, however, of a feebleminded person who was an accomplished artist or an accomplished musician (either performer or composer). All the great musical composers and the great artists were gifted in intellect and imagination. In the writer's investigations of gifted children an extraordinary effort was made to locate children of only average or moderately superior IQ who were outstanding in these special abilities. In a school population of a quarter-million only twenty-six such children were found who showed any unusual promise, and follow-up of these subjects showed that the early promise was not fulfilled in a single case. We may conclude that without superior general intelligence special ability in music and art inevitably falls short of really great achievement. All of the young musicians and artists of genuine accomplishment whom the writer has studied have had, without exception, high intelligence quotients.

Exceptional ability in such fields as mathematics, science, literary composition, or linguistics is, of course, still more intimately bound up with general intelligence, although it is undoubtedly true that among children of a given (high) intelligence quotient some degree of specialization in one or more of these lines may be present. In such cases it is important to discover the direction in which greatest ability lies and to give it appropriate encouragement. Extensive use should be made of tests for the detection of special aptitudes in music, art, mathematics, science, mechanics, composition, and literary appreciation.

The Education of Gifted Children

The education of gifted children has had, and still receives, far less attention than the education of defectives. For one thing, it is so much easier for the teacher to identify backward and defective children. One very surprising result of the Stanford investigation was to show that if one wants to locate the brightest pupil in a given class he stands a better chance of doing so by looking at the birth dates in the register and selecting the youngest child than if he relies upon the judgment of the teacher (107). Moreover, the gifted child, even when recognized as such, is not likely to be thought of by the teacher as constituting a special problem. "Is not the child already accelerated, and doing entirely satisfactory work? What more could you ask?" The teacher does not know that the majority of gifted children have already mastered the work about two grades beyond that in which they are located. Even if she knew it, she would probably oppose extra promotions on the ground that the child would be a social misfit in a class of children so much older than himself. In this she is not entirely wrong, although she is likely to overestimate the dangers of moderate acceleration. It is clear that extra promotions alone do not solve the problem.

One alternative to the present neglect of the problem is to classify all pupils into X, Y, and Z classes, largely on the basis of ability. The Y class, for example, might be made up chiefly of the children between 85 or 90 IQ and 110 or 115 IQ. Then the X class includes those above 110 or 115, and the Z class those below 85 or 90. This plan has much to commend it but it does not solve the present problem adequately. Children of 130 or 140 IQ are so different from children of 110 or 115 IQ that they need a different kind of training. In addition to X Y Z classes there should also be special classes for children of highest IQ and for children of borderline grades of defect.

Special classes for gifted children are rapidly growing in popularity. Germany was a pioneer. A few years ago there were none in the United States. In the 1928-1930 Biennial Survey (44) were reported nearly four thousand children enrolled in one hundred thirty-five such classes in thirty cities of eighteen different states. So satisfactory are the results of this method that few cities which have once established special classes for gifted children have later abandoned them. In the beginning, classes

of this kind were usually formed at the middle or upper pre-high-school grades, but the tendency is becoming more and more to select the children earlier. Selection is made not on the basis of IQ alone, but with consideration for such matters as health, personality, and other factors. Usually, however, few children are enrolled with IQ much below 130. The teachers are carefully selected from the regular force and given extensive freedom in planning the work. As the classes are usually somewhat smaller than the average, the cost is a little greater per pupil than in an ordinary class.

Space is lacking for any extended discussion of the teaching methods suitable for gifted children. Helpful suggestions will be found in the books by Goddard (40), Hollingworth (53), Stedman (97), Adams and Brown (1), Osburn and Rohan (82), and in the *Twenty-third Yearbook of the National Society for the Study of Education* (60). Although methodology in this field is still largely in the experimental stage, it is generally agreed that special classes for the gifted should be conducted in a very different manner from those for average children. Prevalent features include larger individual freedom, emphasis upon project methods, encouragement of work more or less akin to research, and reduction of the amount of time usually devoted to drill. Independent reading and study largely replace textbook assignments, and extensive use is made of class reports, museums, and excursions.

Special classes and the "homogeneous grouping" plan have not been introduced without running the gamut of opposition and criticism. Among the most extended criticisms is that of Keliher (66). The objections which have been advanced center chiefly around three contentions:

1. Some abilities and many personality traits are little correlated with abstract intelligence. Groups segregated on the basis of intelligence are really not homogeneous, and curricula differentiated for various levels of intelligence are therefore unjustified.

2. Segregation on the basis of ability is artificial, and not akin to the segregation by common purposes occurring among adults in the social order. The effect of homogeneous grouping is to breed conceit in the bright and feelings of inferiority in the dull.

3. Educational tests seldom show higher achievement scores for segregated pupils than for unsegregated pupils of like ability.

As to the first point, it is true that children homogeneous in mental-test ability still have their unique patterns. But ability grouping should not excuse the teacher from taking account of the separate traits, interests, and specialized aptitudes of the pupils; it should, on the contrary, leave her much more time to provide for these, since she will be spared the necessity of recasting her teaching for extremely different levels of comprehension. Why grouping by ability should be regarded as more artificial than any other system of grading pupils for group instruction and group progress is not clear. The second point can be better answered by an appeal to experiment and experience. Experience shows that the ill results which

some have feared have not materialized (63, 53, 124). The brighter children are not given undemocratic attitudes or made priggish and conceited. On the contrary, in the special class they encounter for the first time real competition which tends to reduce conceit rather than to increase it. Taking them from the ordinary classes does not reduce the latter to apathy for lack of shining examples; it is rather the presence of gifted children in the ordinary class that makes the average child discouraged. Social adaptation is favored rather than hindered in the special class because of the greater homogeneity in age.

It is unfortunate that after more than a decade of serious and widespread experimentation with special classes and ability grouping, there should be as yet so little crucial data on record regarding outcomes. On the basis of standardized educational tests, few studies have demonstrated marked acceleration of learning by virtue of segregation. However, the studies on this point have been extremely unsatisfactory from a scientific point of view. Frequently the basis of grouping has not been clearly defined or control groups have not been employed. In all cases the time periods covered have been relatively brief. Even with the more carefully conducted studies employing control groups there have usually been two serious difficulties: Either the opportunities for adaptation of curriculum, textbooks, and instructional methods which grouping should make possible have not been adequately utilized, or else the curriculum has been so greatly modified that the new learning thus facilitated does not register on achievement tests designed to measure traditional school subject-matter. In either case, one could hardly expect very significant differences to show up between the measured educational quotients of segregated and unsegregated pupils. The lack of adequate testing techniques is especially to be stressed.

Perhaps the most valuable criterion of outcomes at present available is that established by follow-up of pupils who have enjoyed for a time the opportunities afforded by special classes. That gifted pupils are not unfitted for regular secondary-school classes through special-class attendance in the elementary grades is shown by the superior records of scholastic work and social participation made in high school by the groups which Specht (96), Cleveland (17), and Lamson (71) followed. Coy's (22) group (mean IQ 128) made records somewhat above average, but had more difficulties in adjusting to the junior-high-school regime than is usually the case, chiefly because of teachers' attitudes. There are two studies, by Danielson (24*a*) and by Herschberger (47), which compare the later records of special-class gifted pupils with those of gifted pupils who have attended regular classes. In each case, higher grades were earned by the pupils who had formerly been segregated. Herschberger's study showed in addition that sixty former special-class gifted pupils more often than their gifted controls participated in athletics, dramatics, art activities, office-holding, and committee work, though slightly less often in clubs and musical organizations within the school. This may have been because they

engaged in more activities outside the school (clubs, office-holding, publications, and musical organizations). They received, on the average, higher ratings from their junior-high-school teachers in cooperation, initiative, and industry. Ratings were about equal for the two groups on accuracy, dependability, and leadership. In answer to the question, "In which grades have you been happiest?" the segregated group mentioned the upper elementary grades (in which they had attended the special classes) about twice as often as did the gifted control group.

Gifted Children and the Interpretation of Genius

The mental development of historic geniuses contributes to an understanding of gifted children, and studies of gifted children have an important bearing upon interpretation of genius. Some of these interpretations are fundamentally opposed; other conflicts in viewpoint appear to rise out of definitions rather than out of any real difference in the interpretation of available facts. We may distinguish three main approaches: social explanations, which emphasize recognition and value; psychoanalytic explanations, which deal mainly with motivation; and psychological explanations, which are concerned with the mind and personality of the genius himself.

1. *Social explanations* stress the relationship of the genius to his public and emphasize the dependence of his eminence and permanent value upon the recognition accorded his product (73, 112). Spencer even attributes all the contributions of the genius to the aggregate of social conditions out of which he and his public have arisen. It cannot be denied that the reputation attached to a genius and often his actual achievement depend upon social recognition and opportunity. Nevertheless, the view that geniuses are merely men of average endowment raised to prominence by circumstance has no scientific data to support it.

2. *Psychoanalytic explanations* constitute a link between the social and the more strictly psychological points of view. They tend to emphasize the motivation rather than the intellectual processes of genius. The expressions of genius are said to be compensations for frustrations and inferiorities, or else substitutions for broken emotional attachments (2, 29, 31, 67, 79). In some "analytic" writings the compensatory drives of the genius even seem to be identified with his superior mental processes. Certainly the facts of heritable individual differences, the predominantly good health of gifted children, and their typically superior personality adjustments oppose the latter notion. However, the theory has been neither proved nor disproved that the motivation behind dynamic genius may frequently be compensatory in nature. It seems at least quite probable that, among the components determining the direction in which a genius functions, "complexes" resulting from organic inferiorities or from other misfortunes may sometimes assume major importance.

3. *Psychological explanations,* in which we are most interested, vary enormously, but until recently have had little beyond anecdote, uncon-

trolled observation, and armchair speculation to support them. Two broad divisions may be indicated: (*a*) genius is characterized by psychological processes differing in kind from those of ordinary individuals; (*b*) genius represents the highest endowment in mental traits which are possessed in lesser degree by all.

Qualitative distinction. Historically the first distinction is the older. The Greeks referred to a man's "daemon," which was invested with divine attributes and was supposed to provide the inspiration for his creative work. The Greek conception of the special and unique properties of genius still lives (e.g., the "divine spark"), though by the moderns we are told less about divinity and more about mystic insights and unconscious intuition. Schopenhauer, Carlyle, Mary Austin (5), and others (48, 49) may be grouped here.

There is a group, also deriving from the Greeks, who separate genius qualitatively from normal mentality by linking it with insanity. This view became very popular in the nineteenth century through the writings of Lombroso (76), his predecessors, and followers (41, 81). Several studies have demonstrated the incidence of certified insanity to be no higher in groups of geniuses taken at random (i.e., not constituting selected cases assembled to support a hypothesis as in Lombroso's studies) than in the generality of men (31, 116). The proportion is less than 5 per cent. The pathological interpretation had gained such headway, however, that it died hard, and even recent treatments of genius are influenced by it (69, 72). Lange-Eichbaum (72, 73), for example, finds "explicit psychoses" in 12 per cent of his cases. This relatively high proportion may have been due to selection as to the fields of genius represented. White (116) has shown that, while geniuses as a group are no more prone than others to mental breakdown, they differ according to their fields of achievement, artists and writers being on the average less stable than men eminent in science or statesmanship.

Even if it be admitted, however, that geniuses as a group are not especially prone to insanity, the question remains whether or not they are more often eccentric or neurotic than a random group of men. Galton (34), who viewed ability of genius grade as a normal deviation, nevertheless expressed the belief that men "who are over eager and extremely active in mind must often possess brains that are more excitable and peculiar than is consistent with soundness." Lange-Eichbaum (73) goes so far as to state that 90 per cent of all geniuses have some kind of pathological trend. The problem may be considered still a moot one, but the following observations are germane:

The genius ordinarily lives in a blare of publicity. Legends grow up concerning deviations from conventional behavior that would be scarcely noticed and soon forgotten in ordinary men.

Personality deviations in the genius are possibly expressed in behavior that is more arresting than that rising from deviations of similar degree in ordinary men. Since genius is man on a large scale, its eccentricities show up as upon an enlarged statue.

If genius and instability should prove to be positively linked, it may still be true that the unstable genius achieves in spite of his handicap; that the instability is, in fact, "a Nemesis of the peculiar intellectual energy of genius exerted at a prolonged high tension" (31). Studies of gifted children, as we have seen, offer no support for linking high ability to mental pathology. Gifted children by test and by ratings are more stable and socially more adaptable than average children.

Genius as Highest Talent. The view which places genius within the top small segment of a continuous distribution of complex ability (34) has found wide acceptance. According to this outlook, genius varies by imperceptible shades from a degree scarcely occurring once in a generation to that occurring once or more in a thousand, depending upon where we wish to draw the line between genius and mere talent.

No one would today attempt to simplify genius by identifying it with high intelligence alone. Originality, persistence of motive, judgment, and other qualities in the majority of cases play an important part. Only a few of a group of children whose intelligence is high enough are destined to make contributions of permanent and surpassing importance. However, few would deny that intelligence of fairly high order is a central and indispensable factor in all kinds of genius except those involving the narrowest, most specialized feats of prodigious skill.

The versatility of the mind of genius is one of the consequences of the high general ability upon which it is based. Given different interests and a different training, many geniuses could undoubtedly have made important contributions to fields quite different from their chosen one. Many, in fact, have achieved highly, even eminently, in several different directions. White (117), in a study based upon Cox's material, found that geniuses typically showed achievement in excess of that judged to be characteristic of the "average college graduate" in seven or eight fields outside that of their major work. Gifted children, also, commonly excel in many types of mental work.

To define the nature of genius requires a psychological weighing of its components, unless we are willing to accept the views of those who consider genius merely in terms of the social recognition of its attainments. In addition to the fact that by such a scheme a man long dead may become a genius or cease to be one according as posterity acclaims or forgets, a merely social definition blocks the possibility of discovering and conserving potential geniuses. Moreover, if the subjects of study are not grouped according to any psychological classification, some would be included of fairly ordinary ability who were fortunate enough to produce something of great social usefulness; others would be excluded whose contributions were of great value and involved ability of highest order but who failed to win understanding and appreciation or to linger long in the minds of the public. Judgment as to how to direct one's efforts so as to achieve social approval may rightly be considered as one of the components of

genius, but to identify recognition with the fact of genius is confusing and unfruitful.

If we dispense with sociological formulations, the question immediately arises of the "mute inglorious" genius whose potentialities never flowered. It is impossible to identify him historically, and it may be difficult among the living to determine in a given case whether an able person fails of achievement because of insuperable environmental handicaps or because he lacks the combination of traits which in optimum allotment or combination we call genius. Nevertheless, the concept of unfulfilled genius has theoretical validity, and society's failure to bring out the potentialities of many of its best minds has rueful significance.

Psychologically the kind of ability which in its upper extremes we know as genius is doubtless very complex. It may involve now one weighting of traits and now another, among the most important of the traits being originality, persistence, and judgment. Intelligence of a fairly high order is practically always at its core. Agreement would probably be hard to secure as to the relative importance, on the one hand, of the complexity or the difficulty-level of achievement, and, on the other hand, of discernment as to what constitutes a significant field of directed effort.

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CHAPTER 20

THE FEEBLEMINDED CHILD

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HISTORY

Feeblemindedness is as old as the human race. There have always existed individuals who fell so much below the average intelligence of their fellows as not to be able to take their normal places in the community. In general, however, the reason for this inability was not understood. Only in relatively recent years have we become consciously aware of the fact that this inability to take their normal place in the community is due to feebleness of mind or lack of intelligence.

We have little information as to the feebleminded in ancient times. No particular provision seems to have been made for them in ancient Greece or Rome. They were confused with the insane and demented. The practice of exposure of undesirable children probably eliminated a few, but the great mass of feebleminded, more or less sound in body, undoubtedly escaped.

With the coming of Christianity the sterner attitude of the Roman and the Greek toward the incompetent and the ugly changed to feelings of charity and mercy. Christianity was, first of all, the religion of slaves and outcasts, the hope of the despised and rejected of men. And so, as Christianity spread over Europe, the Church built asylums for those in need. Undoubtedly many feebleminded found a refuge in such places, mixed in among the sick, the lame, the blind, the deaf, and the insane. No clear differentiation between the insane (dements) and the feebleminded (aments) was at first made. They were all "fools." But they were under the special protection of God, and sometimes the ravings or babblings of the poor fool were taken for divine revelations. In France they were called *"les enfants du bon Dieu,"* and in Scotland and Ireland "innocents." They were made fun of at times, revered at others, sometimes whipped if they misbehaved too badly, and in general tolerated rather than persecuted.

In the course of time an appreciation of the difference between feeblemindedness and insanity seems to have slowly arisen. The laws of England began to differentiate between the idiot (*idiota a nativitate*) and the lunatic (*idiota a causa et infirmitate*). In an old law book, *The New Natura Brevium* by Sir Anthony Fitz-Herbert (32), published in Dublin in 1534, we find a clear recognition of feeblemindedness and also the following primitive intelligence tests:

> "And he who shall be said to be a sot and idiot from his birth, is such a person who cannot account or number twenty pence, nor can tell who was his father or mother, nor how old he is, etc., so as it may appear that he hath no understanding of reason what shall be for his profit, nor what for his loss. But if he hath such understanding, that he know and understand his letters, and do read by teaching or information of another man, then it seemeth he is not a sot nor a natural idiot."

Then came the period of the Renaissance and the Reformation. Protestantism, with its emphasis on individual responsibility for a man's deeds, wiped out the tolerance towards the poor fool. Misbehavior was an indication of evil spirits within the man, and so they must be driven out by strenuous treatment. The insane and feebleminded who offended were whipped, bound in chains, cast into filthy dungeons so that the devil might be driven forth. This has been called the era of "whips and chains." It was not the business of the medical man to treat such off-scourings of the human race. His motto was still that of Macbeth's physician: "I cannot minister to a mind diseased."

It is only when we come to the eighteenth and nineteenth centuries that this attitude begins to change. Gradually the scope of medicine begins to enlarge so as to include ills of the mind as well as of the body, and the keeper of the asylum begins slowly to retreat before the physician of the hospital. A scientific interest in these "fools" is aroused, and with it a clearer differentiation between insanity and feeblemindedness. In 1797 a dramatic incident occurred from which sprang the modern study and treatment of the feebleminded. In that year a so-called wild boy was found by some hunters in the woods of Caune in the Department of Aveyron in France. This is the celebrated Wild Boy of Aveyron (*Juvenis Averionensis*). He may be considered the first feebleminded child whose education was scientifically attempted. He was brought to Paris and immediately became the center of a scientific and philosophical battle. Pinel, physician-in-chief to the Bicêtre, a foundling hospital, declared the boy to be feebleminded. But the followers of the philosopher, de Condillac, imagined him to be a normal individual deprived of ordinary experiences, and so considered him an admirable subject by means of which they could watch the process of the formation of new ideas by means of new sensations in the gradual transition from savagery to civilization. The task of education was enthusiastically undertaken by Itard, the physician of the Institution for Deaf Mutes. Itard (45) worked hard and accomplished much, but could not restore the boy to normality. Gradually he began to doubt the boy's mental integrity, and when at last he became convinced that he was an imbecile or idiot, he threw up the work of education in despair, because he shared the common belief that idiots were separated from normals by a great gulf which could not be bridged. So the boy was sent to the Bicêtre as a custodial case unworthy of training.

Itard considered his work a failure because he had not demonstrated

that his patient was normal. He failed to appreciate how much he had really taught the boy. Seguin, a pupil of Itard, had watched his master with great interest and had marvelled at the progress made by this feebleminded boy. In 1837 he commenced the training of a few cases of feebleminded children. In 1842 he convinced the authorities of the desirability of educating the idiots and imbeciles at the Bicêtre and he was put in charge of the school there. This marks the beginning of state schools for the feebleminded. His *Traitement moral, hygiène et éducation des idiots* has been called "the emancipation proclamation for the fettered soul of the idiot" (Johnson, 46). It acted as a great stimulus to the education of the feebleminded. Seguin came to the United States in 1848 and did much to stimulate the work for the feebleminded in this country both by his practical work and by his writing (75).

The various states now began to open institutions for the care and training of the feebleminded. Towards the close of the century, school systems began to organize special classes for the dull and feebleminded, and in 1896 the psychological interest in these cases was typified by the opening of the first psychological clinic under Witmer at the University of Pennsylvania.

The last important influence in the study of feeblemindedness lies in the work of Binet. He constructed a scale for the measurement of intelligence, demonstrated that feeblemindedness was merely a lack of intelligence and not a disease, that it differs from normal intelligence merely in amount, that there is a continuous gradation of intellects from normal to feebleminded, and therefore no wide gap between normality and feeblemindedness. He gave us the quantitative concept of feeblemindedness. In 1905, in collaboration with Simon, Binet (9) pointed out the unsatisfactory nature of the usual methods of diagnosing feeblemindedness and offered his first scale to increase the accuracy of such diagnosis. In later years Binet and Simon revised and improved this measuring instrument, and its value spread far beyond the domain of feeblemindedness. Binet gave us the concept of mental age as a measure of the level of intelligence. He also pointed out clearly the difference between arrest of development of intelligence (feeblemindedness) and disturbance in the functioning of intelligence (insanity). Perhaps we can best sum this all up by saying that Binet, more than any other individual, stimulated the scientific study of feeblemindedness. Thousands of workers in all countries have found inspiration directly or indirectly from his ideas.

Notable work has been done in recent years on the measurement of the intelligence of the feebleminded, on the rate of growth of intelligence, on the causation of feeblemindedness, particularly from the point of view of heredity, and on the education and treatment of the feebleminded. References to the workers will occur later on as we take up these various topics This must suffice as a brief historical background to our topic.

DEFINITIONS

Some of the earliest definitions are of the legal type, because the courts were constrained to give decisions concerning the acts or the property of imbeciles and idiots. Coke says:

> "An idiot, or natural born fool, is one who from his nativity, by perpetual infirmity, is *non compos mentis*."

And Blackstone:

> "An idiot, or natural born fool, is one that hath no understanding from his nativity, and is therefore by law presumed never likely to attain any."

Note that these legal definitions lay emphasis upon the lack of intelligence from birth.

Early medical definitions (Hollingworth, 42) consider feeblemindedness as a sickness. Thus Delboe says:

> "Even the condition of many stupid men is to be designated sickness, whereby they are not able to reason nor to recognize cause and effect."

And Willis writes:

> "Idiocy and stupidity depend on a lack of judgment and intelligence, the actual rational mind being not concerned; the brain is the seat of the sickness, which rests on a lack of imagination and memory, the seat of which is in the brain. The imagination is located in the corpus callosum, or the white substance; the memory in the cortical substance. So if imbecility or stupidity arises, the cause is in the brain region involved or in the animal spirits, or in both."

Hollingworth also gives an interesting early psychological definition of Herbart's:

> "Idiocy and imbecility, which alone of all the mental disorders appears to be inborn, and which—as the opposite extreme of genius, is general weakness of the mind,—does not differ so much in quality as in degree, and may go so far that the man almost resembles a plant, but as such grows and is healthy."

None of these older definitions took account of the social consequences of feeblemindedness. Most of our modern definitions do. Most of them are based upon the definition formulated in 1904 by the British Royal Commission on the Feebleminded (12):

> "A feebleminded person is one who is capable of earning a living under favorable circumstances, but is incapable, from mental defect existing from birth, or from an early age, (*a*) of competing on equal terms with his normal fellows: or (*b*) of managing himself and his affairs with ordinary prudence."

The criterion here is obviously sociological, namely, the ability to get along in society, and such a criterion is, of course, the only one of any conse-

quence from the point of view of the control of the feebleminded. All people who cannot get along in society must be taken care of, and the feebleminded belong to this larger group.

This definition was adopted in the British Mental Deficiency Act of 1913, but it was amended in 1927 so as to define mental defectiveness as

> "a condition of arrested or incomplete development of mind existing before the age of eighteen years, whether arising from inherent causes or induced by disease or injury."

This allows children whose mental development was normal up to the time of some accident or disease to be classified as feebleminded.

The influence of the above definition is seen in the British Mental Deficiency Act of 1913, which classified mental defectives into three grades as follows:

> "The feeble-minded are persons in whose case there exists from birth or from an early age mental defectiveness not amounting to imbecility, yet so pronounced that they require care, supervision, and control for their own protection or for the protection of others, or in the case of children, that they by reason of such defectiveness, appear to be permanently incapable of receiving proper benefit from the instruction in ordinary schools.
>
> "Imbeciles are persons in whose case there exists from birth or from an early age mental defectiveness not amounting to idiocy, yet so pronounced that they are incapable of managing themselves or their affairs, or, in the case of children, of being taught to do so.
>
> "Idiots are persons so deeply defective in mind from birth or from an early age, as to be unable to guard themselves against common physical dangers."

All these sociological definitions are merely practical guides as to who should be committed to special care or supervision. They all beg the real question, because they say that the inability is caused by mental defect. Thus, having an incompetent before us, we must decide whether his incompetency is due to mental defect or laziness or dementia or whatnot. Furthermore, competency in society depends upon the degree of complexity in any given social group. The reliance upon this criterion alone might mean that an individual might be called normal in a simple rural environment, but feebleminded if he moved to a complex urban environment. From the point of view of supervision and control, this is perfectly satisfactory, but it gives us no insight into what degree of mental defect constitutes feeblemindedness.

Medical definitions of feeblemindedness generally postulate hypothetical physiological causes. Thus Sajous (73) claims that

> "the main underlying cause of defective mentality in both parent and offspring is inherited deficient activity of the ductless glands."

And Ireland (44) says:

> "Idiocy is mental deficiency or extreme stupidity, depending upon

> mal-nutrition or disease of the nerve centers, occurring either before birth or before the evolution of the mental faculties in childhood."

Tredgold (83), one of the best medical authorities on feeblemindedness, avoids any specific physiological cause, merely postulating arrest of cerebral development, and incorporates the sociological criterion. His definition is:

> "We may accordingly define amentia as a state of restricted potentiality for, or arrest of, cerebral development, in consequence of which the person affected is incapable at maturity of so adapting himself to his environment or to the requirements of the community as to maintain existence independently of supervision or external support."

The difficulty in all these definitions, whether medical or sociological, is the determination of mental defect or arrested development. It is just here that mental measurement comes to our aid. The work of Binet in mental testing has led to psychological definitions of feeblemindedness which emphasize the degree of mental development as the crucial factor. Binet and Simon were naturally the first to suggest that degree of feeblemindedness could be best defined in terms of mental age, but they did not limit their definitions entirely to this. Thus they say:

> "An idiot is a person who is not able to communicate with his fellows by means of language. He does not talk at all and does not understand. He corresponds to the intelligence level of a normal child ranging from early infancy to two years of age."

The mental-age limits for idiots are zero to two years; for imbeciles, two to seven years; for morons, above seven years.

This mental-age type of definition is again reflected in the definitions adopted by the American Association for the Study of the Feebleminded in 1911:

1. The term "feebleminded" is used generically to include all degrees of mental defect due to arrested or imperfect mental development as the result of which the person so affected is incapable of competing on equal terms with his normal fellows or managing himself or his affairs with ordinary prudence.
2. Idiots are those so deeply defective that the mental development never exceeds that of a normal child of about two years.
3. Imbeciles are those whose development is higher than that of an idiot but does not exceed that of a normal child of about seven years.
4. Morons are those whose development is higher than that of an imbecile but does not exceed that of a normal child of about twelve years.

In a similar fashion we find Doll (26) defining feeblemindedness as

> "a condition of arrested development, specifically of the general intelligence, which limits the individual to mental capacity not exceeding that of twelve-year-old normal children."

These mental-age definitions all refer to individuals who have reached mental maturity. For those still growing, the definition is usually in terms of IQ. Hollingworth (42) says:

> "Idiots grade roughly from 0 to 20, imbeciles from 20 to 40, and morons from 40 to 70."

All these mental-age and IQ definitions are predominantly psychological. They substitute "mental" development for the physiological concept of "cerebral" development. They lay stress upon general development as opposed to specific abilities. The sociological results of this arrested development are secondary, the assumption being that an individual of such restricted mentality would fall below the required social standards.

There is still another type of definition which may be called statistical. This arises from the results of mental testing and the fact that the distribution of mental ability is continuous and not discrete. There is no dividing line between any of the different kinds of feebleminded and normal individuals. Feeblemindedness is simply the lower end of the curve of normal distribution of intelligence. It becomes, therefore, a matter of convention as to where the line between normality and feeblemindedness is drawn. Pintner and Paterson (68) suggested that the lowest 3 per cent and Miner (56) the lowest .5 per cent be considered feebleminded. Burt (16) also argues that

> "for immediate practical purposes the only satisfactory definition of mental deficiency is a percentage definition based on the amount of existing accommodation."

This practical definition is admittedly based upon the ability of society to care for its intellectually weakest members. At present Burt suggests that in the county of London

> "the mentally defective child is to be defined as one who for intelligence ranks among the lowest 1½ per cent of the school population of the same age."

This lowest 1½ per cent would include, according to Burt, all those falling below a deviation of minus 2 *S.D.*, or an IQ of about 70.

These statistical definitions have not found favor among psychologists, physicians, or social workers. Perhaps this is owing to the fact that we still think of feeblemindedness as some definite entity, like insanity or measles or chickenpox, which an individual either has or has not. We do not yet think readily in terms of continuous variation. The adoption of such a statistical definition of the term "feeblemindedness" would immediately divest it of all its sociological implications. An individual would be considered feebleminded simply because he fell in the lowest x per cent as determined by intelligence tests. Because of this he would need a special type of education. His character, temperament, and emotional stability would determine whether or not he might need to be segregated in some colony or institution or whether he might be allowed to remain in society either with or without supervision.

It has been objected to this percentage definition of feeblemindedness that it is a fluctuating concept inasmuch as the amount of intelligence

possessed by the lowest x per cent may differ from country to country and from century to century. To the extent that there are differences in the intelligence distribution of various national groups, this is perfectly true. If a given percentage for the whole world were agreed upon, then the incidence of feeblemindedness might differ in different countries. But each country might, as Burt suggests, determine its own percentage for its own immediate practical purposes. To the extent that intelligence is increasing or decreasing from century to century then the amount of intelligence regarded as feeblemindedness might increase or decrease, provided no change were made in the percentage definition.

It is obvious from a discussion of all these definitions of feeblemindedness that the difference of opinion arises because of the fact that the standard definitions generally try to combine two different things which are highly but not perfectly correlated. These two variables are lack of intelligence (in the rather narrowly restricted psychological sense) and social incompetency. The first can be fairly well measured. The second is a vague concept. If these two variables could both be accurately measured, and if they then correlated perfectly, everyone would be agreed as to what feeblemindedness is. This is true of the lowest grades of the feebleminded, namely the idiots and imbeciles. They are low in intelligence and also socially incompetent. But when we come to the larger group above these lower grades, we find those socially competent but fairly low in intelligence and also those socially incompetent but fairly well endowed intellectually. What we call these individuals will depend upon whether we stress "the social incompetency" part of our definition or "the degree of mental defect" part of the definition. The term "feeblemindedness" is thus ambiguous. It attempts to be both sociological and psychological at the same time. We need two separate terms. Term A would refer merely to mental defect, and those so low in general intelligence would need a special type of education. Term B would refer to social competency, and those falling below a certain level would need social assistance. Those below the line in both of these measures would constitute the inmates of our institutions for the feebleminded.

Diagnosis

Much of the discussion above leads us naturally to the question of diagnosis, for our concept or definition of feeblemindedness will determine very largely our diagnosis. And a diagnosis is usually made with an eye to treatment. Hence it will come about that certain examiners will give more weight to intellectual deficiency and others to social incompetency. But for almost all examiners at the present time the main instrument for diagnosis is usually some intelligence scale, most frequently the Binet-Simon scale.

This scale was indeed the outcome of Binet's revolt against the subjective and casual methods employed in the diagnosis of mental deficiency

in the past. Now, in its revised and modified forms, it represents our most useful diagnostic instrument. This is not the place to describe and explain the technique of intelligence testing. Such description, with numerous references, can be found in the books of Pintner (67), Freeman (34), Terman (80), and many others. In brief it may be said that if a child's IQ falls below 70, or if an adult (i.e., anyone above age fourteen) fails to make a mental age of 10 or above, there is grave suspicion of mental defect. If the retardation is very great, and if nothing of importance turns up in the case history, one thorough individual intelligence test may suffice. If, however, the retardation is near the upper limits mentioned, and if there are any extenuating circumstances, then the examiner usually proceeds to further testing. He may give a different type of scale, such as the Pintner-Paterson performance scale or the Porteus scale or he may give other single tests (see Bronner, 13), or he may use a different revision of the Binet-Simon scale a week or so later, in order to check up on his first examination. From the total result of this testing and from his case history, he will then come to some judgment.

In all cases it is well to have a thorough medical examination before a final diagnosis is made and certainly before recommendations for future treatment are made. Before individuals can be committed to institutions for the feebleminded a medical examination is usually compulsory. Some types of insanity, deafness or visual deficiency, extreme shyness, or language disability may all cause an individual to do very badly on an intelligence examination, and this inability may not be primarily due to mental defect.

With children below the age of three or four the diagnosis of mental deficiency is more difficult, because our present intelligence scales are not so accurate for the low ages. The Minnesota pre-school scale and the Merrill-Palmer scale are the best testing instruments here. For very young children, particularly during the first year of life, Gesell's developmental schedules are of major importance. Except in cases of extreme mental retardation, the certainty of diagnosis in these early ages is not so great. The young child is developing so rapidly and has so much potentiality of development ahead of him that most examiners are cautious and willing to give any case the benefit of the doubt. Nor in general is the need for diagnosis so pressing. Retests at six-months intervals will ordinarily show whether a child is developing normally or so slowly as to put him definitely in the feebleminded class.

In addition to the results of the intelligence examination the examiner will gather further information about the case. A developmental history will throw light upon the general growth of the child. The ages at which the child began to walk and to talk are important here. Severe diseases in childhood should be noted. A family history will seek to establish the mental status of related individuals. A great number of feebleminded relatives will be indicative of a generally poor intellectual stock. A school history, if the child is of school age, is important, because mental deficiency early shows itself by inability to make normal progress in school. Standard

educational tests may be given to supplement the information received from the school. With older children or adults a vocational history may be important. Wherever there is a suspicion of complicating factors, a sensory examination and a neurological examination may be necessary. The final diagnosis, the prognosis, and the recommendations for treatment will be made in the light of all this information. A mere intelligence examination is not sufficient, although this may be the one most important item. The work should be done by an experienced clinical psychologist who is able to evaluate all of the many factors in each individual case.

INCIDENCE

The prevalence of feeblemindedness in the general population has been a matter of much discussion, and various estimates have been made. Table 1 gives a sample of the estimates made by various authorities either for the country as a whole or for specific portions thereof. Some of these percentages are opinions, others are based upon the results of surveys of school children with intelligence tests, and others upon rather detailed surveys of the total population of a given area. In the light of our discussion as to the definition and diagnosis of feeblemindedness, it can readily be seen that workers investigating the same area might easily differ as to the number of feebleminded. Much would depend upon where a particular worker placed the upper limit of feeblemindedness. Furthermore, a given section of the country might differ from another in the number of feebleminded, although hardly to the extent of having more than eight times the number of feebleminded as is the case with X County, Minnesota, when compared with Oneida County, New York, in our table. Popenoe's (69) recent estimate of 4 per cent for the United States is based upon the results of

TABLE 1

ESTIMATES OF THE PREVALENCE OF FEEBLEMINDEDNESS

Authority	Percentage	Bibliographic reference
British Royal Commission, 1908	0.40	12
Oregon Survey, Carlisle, 1921	0.50	19
United States, Bailey and Haber, 1920	0.65	3
Wisconsin Schools, Cary, 1916-18	0.70	20
British Mental Deficiency Committee, 1929	0.73	72
Oneida County, N. Y., Carlisle, 1918	0.73	18
Porter County, Ind., Clark, 1916	0.90	21
Rural County, Ohio, Sessions, 1918	1.80	76
Rural Survey, Del., Mullan, 1916	1.80	61
Toronto Schools, Smith, 1920	2.00	79
Goddard's estimate, 1914	2.00	39
Terman's estimate, 1916	2.00	80
Cleveland Survey, Mitchell, 1916	3.00	58
Popenoe's estimate for U. S. A., 1929	4.00	69
X County, Calif., Terman, 1918	4.24	81
Eight Minnesota towns, Kuhlmann, 1923	4.70	51
X County, Minn., Anderson, 1922	6.10	2

various surveys of school systems, states, and so forth. This would mean about five million feebleminded persons. This estimate is twice that of such authorities as Goddard and Terman. It is also very much higher than the estimate of Bailey and Haber (3) based upon the findings in the army during the War.

The two British estimates of 0.40 per cent in 1908 and 0.73 per cent in 1929 merit particular attention. The Royal Commission on the Care and Control of the Feebleminded was appointed in 1904, made a detailed survey of the number of persons suffering from all forms of mental disease as of January 1, 1906, and published its final report in 1908.[1] The method adopted was to select certain typical areas, urban, industrial, agricultural, and mixed, and then to comb these areas very thoroughly for all feebleminded individuals. No intelligence tests were used. The medical men making the inquiry visited schools, penal institutions, asylums, hospitals, and charitable institutions and gathered information from all medical practitioners, clergymen, police, charitable organizations, and any other person or agency likely to know of mentally deficient individuals. From the number of feebleminded found in these selected areas, an estimate for the whole country was arrived at. The Mental Deficiency Committee of 1929 made a similar survey, with the notable addition of intelligence testing. Group tests were given to all retarded children and then individual Binet tests to all suspected cases. Age fourteen was used in calculating IQ's, and the following ranges for the three degrees of amentia were adopted: idiots below 20, imbeciles from 20 to 40, and feebleminded (or morons) from 40 to 60. The percentage of defective children in the six areas examined was found to be 0.85 per cent, the urban areas showing 0.67 and the rural 1.05 per cent. The estimated incidence for the total population of Great Britain was 0.73 per cent. The author of this report notes that this estimate is about twice that of the Royal Commission made twenty-three years previously. He believes that this increase in the estimate is due to three important factors: (*a*) a more thorough ascertainment of cases, due to the use of intelligence tests; (*b*) the increased longevity of the feebleminded, due to better health conditions; and (*c*) a slight increase in the birth-rate of feebleminded cases, particularly in the rural districts. He calls attention to the fact that not only has the total estimate for the feebleminded increased, but that the percentage of idiots has also increased, and idiots would not have been overlooked in the previous survey.

These two British surveys represent the most reliable estimates of the conservative type that we possess. The earlier one undoubtedly underestimates the number of feebleminded; the recent one probably includes most individuals with an IQ below 60. For adults (i.e., individuals of age fourteen and above) the upper limit of feeblemindedness would be about MA 8-6. In all probability, therefore, we may take this estimate of about

[1]This is the reason why it is referred to in the literature of our subject as the Royal Commission of 1904 or 1906 or 1908.

1 per cent of the population of countries like Great Britain or the United States as being feebleminded in the sense that the degree of mental defect is so great as to make them practically useless in modern society. If we increase our concept of social competency, undoubtedly a larger number will fail. The percentage of feebleminded will vary from about one to three according to our concept as to what constitutes social competency and as to what degree of intelligence constitutes mental deficiency.

Whether there is any difference in the percentages of male and female feebleminded is still an open question. Hollingworth (42) shows that nearly all reports from institutions and clinics report a larger percentage of boys, e.g., 54 per cent boys and 46 per cent girls, and she also shows that this is due to the fact that the girl is more protected by the home and can pass off as socially competent with a lower MA than a boy can. Her conclusion is that there is no real difference between the sexes. The recent British report, however, finds a much higher percentage of male than female idiots. The incidence is 30 per cent higher for boys than for girls. All of this difference would hardly seem to be reconcilable by Hollingworth's explanation.

A greater percentage of male idiots, together with a greater percentage of male geniuses, as found by Terman and others, fits well into the theory of the greater variability of the male sex—a theory advanced to explain the greater preeminence of the one sex over the other.

With reference to the incidence of feeblemindedness among different sections of the population, we cannot here go into detail because of the extent of the work done. We must content ourselves with some broad generalizations. Poorly developed or so-called backward sections of the country generally report more feebleminded persons than do progressive sections. Rural regions in general have a larger percentage than urban regions. Note the British estimate of 0.67 for urban and 1.05 for rural districts. With reference to the percentage of feebleminded among delinquents estimates differ widely (56, 17, 67). Early reports based upon intelligence testing revealed a larger percentage than more recent reports. One or two authorities find no difference between the intelligence of adult male prisoners and the general population. Differences in percentage will depend upon the type of prison investigated. Federal and state penitentiaries would seem to include fewer feebleminded than local jails and workhouses. In general, the percentage of feebleminded among juveniles is greater than among adults, and greater among females than among males. The girl is not sent to a reformatory as readily as the boy, because the moral obloquy attaching to her on this account is so much greater than is the case with the boy. Feeblemindedness cannot in any sense be called the cause of delinquency, although in many cases it may be a contributing factor. Among the unemployed, particularly those chronically out of work, the percentage of feebleminded is presumably higher than among the steadily employed. Among the physically handicapped groups the percentage of feeblemindedness is reported to be higher among the deaf and the blind.

Classification

Classification of the feebleminded is either according to degree of mental defect or according to clinical types. Classification according to degree is most useful educationally and is of chief interest to the psychologist. Classification according to clinical types is due largely to the medical workers in the field and is of chief interest to them.

As there are all degrees of lack of intelligence from the normal to the extreme idiot, without a break, any number of divisions are theoretically possible. In actual practice three main divisions of the total feebleminded group are now generally recognized. In America these three groups are called idiots, imbeciles, and morons. In England the last group is called feebleminded and the generic term for the total group is ament. The definitions of these three groups according to the English Mental Deficiency Act of 1913 and the definitions adopted by the American Association for the Study of the Feebleminded have been quoted above under our discussion of the definition of feeblemindedness. The first set of definitions applies the criterion of social competency, the other that of mental age. The idiot is an individual of very low mental age (up to about MA 2), who cannot look after himself adequately and cannot protect himself from common physical dangers. The imbecile is low in mental age (from MA 3 to about 6 or 7), can rarely be taught to read and write, and can do only the simpler tasks of life. The moron is much higher in mental age (from MA 6 or 7 to MA 8 or 9), can be taught the rudiments of reading, writing, and arithmetic, and can do many tasks in life under supervision, but fails in competition with normal individuals.

The mental-age dividing lines between these three groups are mere arbitrary divisions, as they must be where we have a continuous distribution, and there is not yet any common consent as to just where they should be placed. If, for example, the most recent suggestion adopted in the British Mental Deficiency Report of 1929 be taken, then the MA of idiots would range from 0 to 3, the MA of imbeciles from 3 to 5-8 or 5-9, and the MA of morons from 5-10 to 8-6. This upper limit of 8-6 is a long way from the upper limit of 12, proposed in the early days of mental testing. It is certainly much more in keeping with modern thought on the upper limits of feeblemindedness. Some would extend the MA to 9-11 or just below MA 10, this giving an IQ of 70 calculated on the basis of CA 14. But no authority would now-a-days contend that all those having MA's of 10 and 11 be classified as feebleminded. If we apply these limits to the army results, we note that an upper limit of MA 8-6 would cut off about 3.7 per cent; an upper limit of MA 9-11 would include about 10 per cent. Similarly, when applying these limits to a random sampling of 17,502 school children, not including children in special classes, I find that 1.28 per cent fall below IQ 60, and 5.72 per cent below IQ 70. It is therefore probably wiser to consider the upper limit of feeblemindedness as lying somewhere in the neighborhood of IQ 60 and MA 8-6.

This quantitative classification according to degree or amount of mental defect is of supreme importance for training. The MA or mental level gives us a fair idea as to what the child can accomplish educationally. Since the IQ is fairly constant, the IQ tells us the probable rate of development and also the probable limit which the child may reach.

The other method of classification, according to clinical types, is of more interest to the medical man. It is of little interest to the psychologist and educator. In one sense it is a very poor system of classification because it leaves the vast mass of ordinary feebleminded undifferentiated. As Lapage (52) says, after describing six clinical types, "91 per cent of the feebleminded are not of any special type."

The physical types generally include the cretin, the Mongol, the microcephalic, and the hydrocephalic. Sometimes the paralytic, the epileptic, and the insane are also included, but these are obviously cases where a second handicap is added to the original one of feeblemindedness. Other writers have described a negroid type, an American Indian type, and a criminal type. Some have divided idiots and imbeciles into excitable and apathetic. Almost all writers describe a group known as *idiots savants*. For numerous pictures of the so-called types the reader is referred to the works of Tredgold (83) and Barr (4). For the best collection of pictures of feebleminded individuals in general, without any attempt to classify them into types, the reader should consult Goddard (39). An impartial study of this portrait gallery of Goddard's will surely convince the student that the feebleminded in general have no obvious physical characteristics that differentiate them from the normal. We reproduce here through the courtesy of Dr. H. H. Goddard and the Macmillan Company four pages of these portraits. Goddard's pictures give one a much better idea of the general run of feebleminded individuals than do the pictures in the usual textbook, because in the latter the exceptional types are usually alone portrayed, and these exceptional types, we must remember, include only a very small percentage of the total feebleminded.

There are four types, however, that are met with in almost any large institution, and these merit short descriptions. These are the cretins, the Mongols, the hydro- and microcephalics. Cretinism is a very old disease and is found scattered all over the world. It is due to a disturbance of the functioning of the thyroid gland. Tredgold's (83) description is as follows:

> "In consequence of this condition of the thyroid a marked alteration takes place in the bodily and (usually) mental state of the person affected. In congenital or infantile cases the whole nutrition of the body is disturbed. There is a marked diminution in the number of red blood-corpuscles as well as in the percentage of haemoglobin. The child, whilst usually remaining fat and puffy, makes very little growth, and the majority of these persons remain dwarfs. The skin is sallow or actually yellow, dry, thickened, and wrinkled, and has the appearance of being too large for the body. The head is large and

FIGURE 1

Case 56, King B., age 37. Mentally 7.
Case 57, Horace C., age 14. Mentally 7. His two brothers.
Case 59, David D., age 15. Mentally 7.
Case 61, Bessie I., age 13. Mentally 7.

(From H. H. Goddard's *Feeble-Mindedness*. By permission of The Macmillan Company, publishers.)

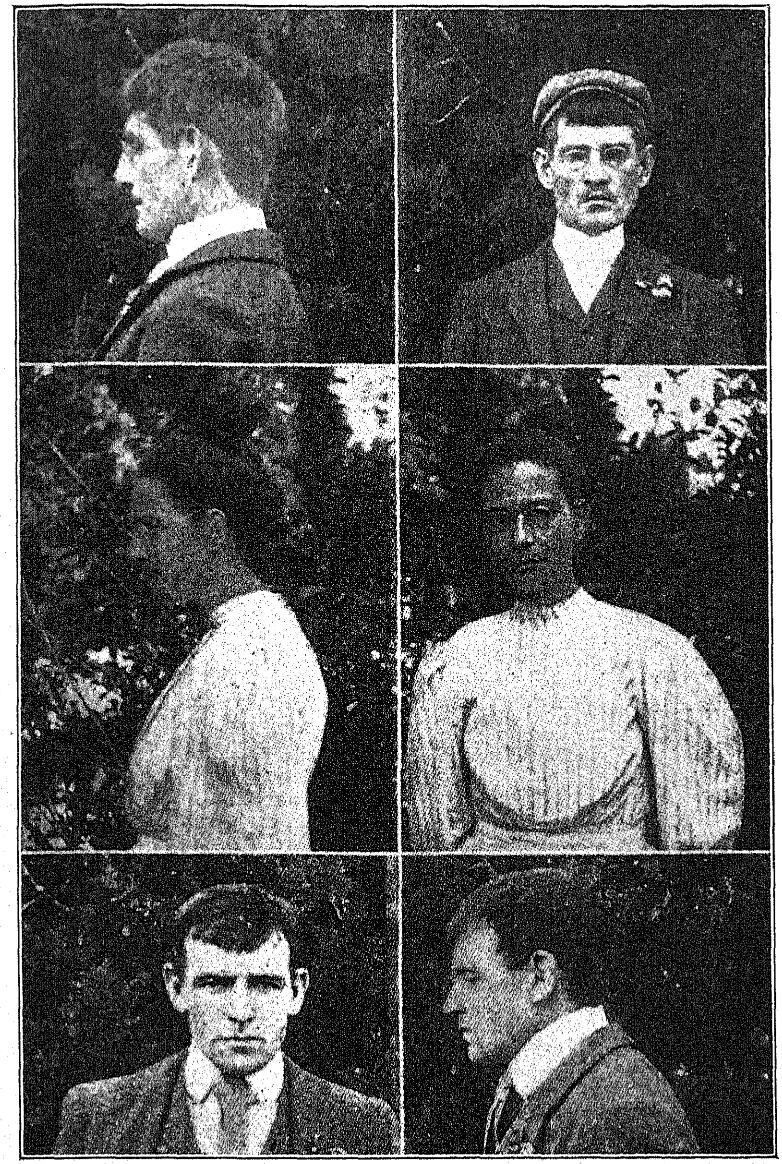

FIGURE 2

Case 83, David X., age 31. Mentally 6.
Case 83, Nancy X., age 29. Mentally 6.
Case 85, Herman C., age 28. Mentally 6.

(From H. H. Goddard's *Feeble-Mindedness*. By permission of The Macmillan Company, publishers.)

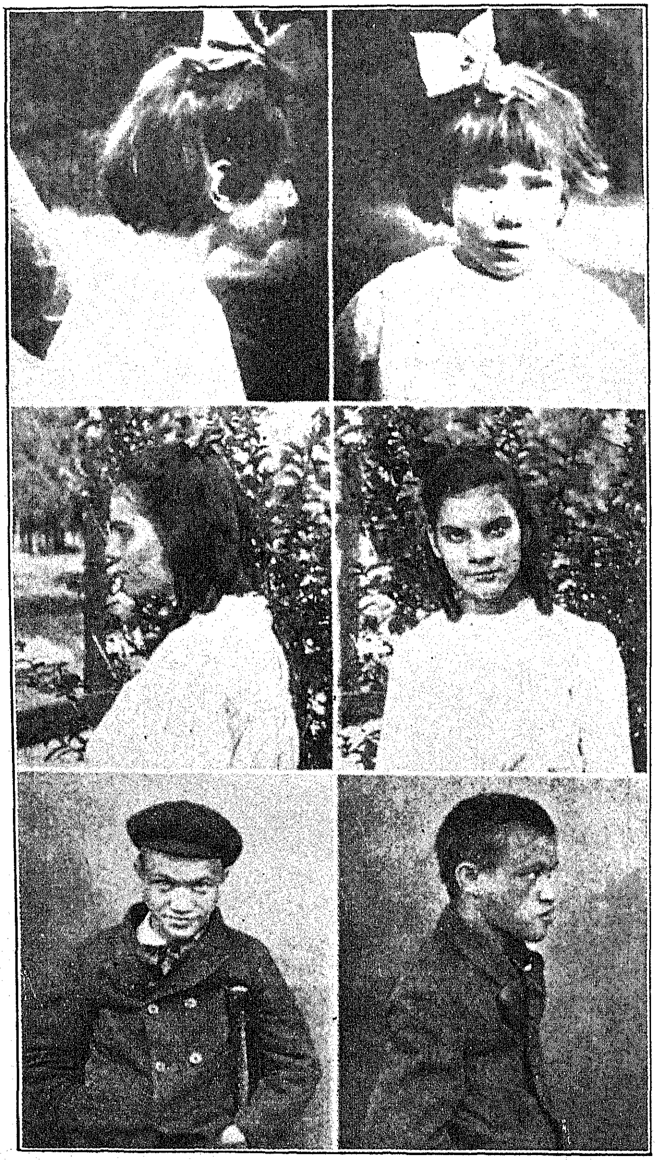

FIGURE 3
Case 118, Mollie I., age 10. Mentally 1.
Case 119, Delia I., age 25. Mentally 4.
Case 120, Charlie M., age 26. Mentally 4.

(From H. H. Goddard's *Feeble-Mindedness*. By permission of The Macmillan Company, publishers.)

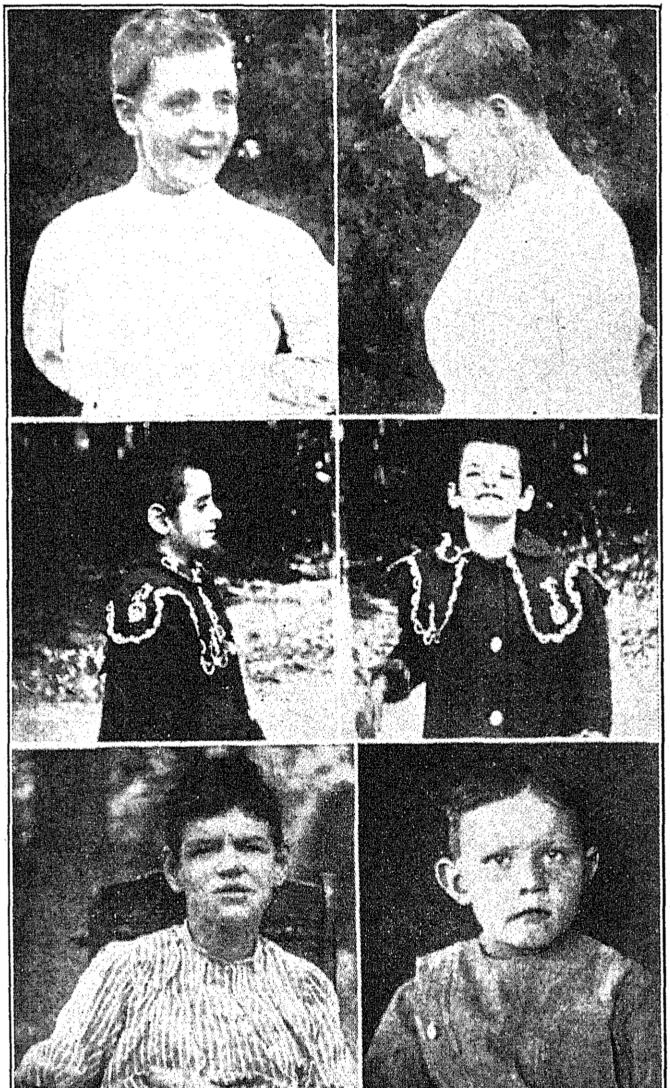

FIGURE 4

Case 140, Nellie E., age 24. Mentally 2.
Case 141, Nora E., age 13. Mentally 2.
Case 142, Nancy F., age 21. Mentally 2. (lower left)
Case 150, Izzy P., age 12. Mentally 2. (lower right)

(From H. H. Goddard's *Feeble-Mindedness*. By permission of The Macmillan Company, publishers.)

> the fontanelles are late in closing. The nose is broad and flat, the lips thick and swollen, and the tongue is so large that it often hangs out of the open mouth. The belly is protuberant, and the lower limbs short and bowed. The whole body is unwieldy, its balance unsteady, and its gait ungainly. Puberty is often delayed, and many pronounced cretins are sterile. In fact, these children as a whole present bodily signs identical with those of the sporadic variety. In those cases in which the disease is acquired in later life, as a consequence of residence in a goitrous locality, changes analogous to those occurring in myxoedema are produced."

Cretins would seem to possess all degrees of mental defect. The more pronounced the physical characteristics, the more pronounced the mental defect. Children having some of the cretin characteristics are to be found among the high-grade feebleminded and even among the dull normal. Cretinism is one of the only types of mental deficiency for which some treatment seems available. Under the influence of thyroid treatment many of the physical anomalies clear up, particularly if the treatment is more or less continuous and is begun at an early age. Along with this physical improvement goes some mental improvement, but, according to Tredgold (83), "it is the general experience of those who have knowledge of these persons that the mental is rarely commensurate with the bodily development."

Mongolism, as a special clinical type, was first described by Langdon Down (28) in 1866, and was so called because of the supposed resemblance of these cases to the Mongolian race. Figures 5, 6, and 7, reproduced by the courtesy of Brousseau and Brainerd (14) and the Williams and Wilkins Company, show typical Mongols from which we can see that this supposed resemblance to the Mongolian race is not very great. Figure 6 shows the difference between the cretin and Mongol. The literature on Mongolism is extensive and the best recent survey of the whole field is the work of Brousseau and Brainerd (14). Because these cases resemble each other to some extent, it would seem as if there should be some specific cause, as in cretinism. Numerous causes have been suggested, but there is as yet no general agreement. Because these cases often occur in families where there seems to be no other mental defect, the age of the parents at the birth of the child and the order of birth have been investigated. Brousseau and Brainerd's statistics on these points show that neither the advanced age of the mother or father or the fact of being the last-born in a family point to causative factors in Mongolism. These authorities conclude that it must be caused by some obscure disturbance of the ductless glands. Mentally the pronounced Mongol would seem to be very retarded, Brousseau and Brainerd classifying 206 Mongols as 38 per cent idiots, 61 per cent imbeciles, and 1 per cent morons. The average age of death for 165 cases is fourteen, the oldest dying at age forty-one.

The hydrocephalic and microcephalic are rarer than the cretins or Mongols. The large head of the hydrocephalic is caused by an excess of

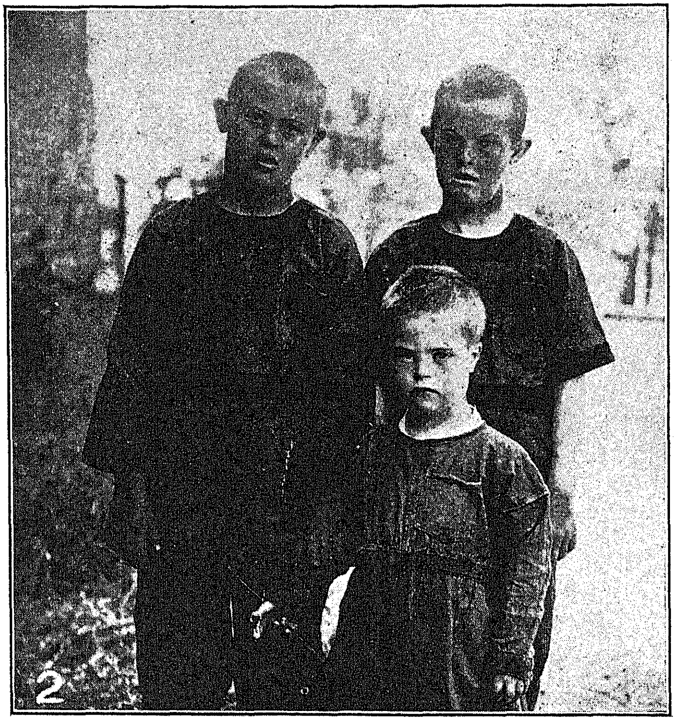

FIGURE 5
MONGOL BOYS
(From K. Brousseau and H. G. Brainerd's *Mongolism.* By permission of the Williams and Wilkins Company, publishers.)

cerebro-spinal fluid in the brain. The small head of the microcephalic, whose skull measures less than 17 inches in its greatest circumference, is not caused by any known diseased condition. Figure 8 shows pictures of microcephalics copied from Barr (4). Case F on this picture shows the attempt by means of craniectomy to allow the brain to grow, because at one time microcephalus was thought to be caused by a premature cessation of growth of the skull. Microcephalics are almost always extremely mentally retarded. Hydrocephalics, on the other hand, are found among all grades of intelligence, depending largely on the severity of the disease. Excess amounts of cerebro-spinal fluid may be found in the brains of people of normal or above-normal intelligence. Figure 9 shows two cases of hydrocephalus contrasted with a case of microcephalus.

This must suffice for the clinical varieties of feeblemindedness. The numbers belonging to these types are small, and our interest in these peculiar and freakish individuals is out of all proportion to their numbers. It is to be hoped that our pictures of the ordinary feebleminded in Figures

FIGURE 6

LEFT, MONGOL; RIGHT, CRETIN

(From K. Brousseau and H. G. Brainerd's *Mongolism*. By permission of the Williams and Wilkins Company, publishers.)

1, 2, 3, and 4 will help to counterbalance the effect of the more striking pictures portraying the clinical types.

There is another type of feebleminded described in the textbooks that merits a few words. This is the *idiot savant*. Earlier writers used to pay much attention to these so-called "wise idiots." Pintner (67) remarks:

> "The descriptions of most of these cases are not very convincing to the modern psychologist, because they lack the quantitative measures of intelligence by means of which he could judge the performances described. To the old-fashioned observer, who thought of the idiot as a thing apart, belonging to a different species, it must have been a decided shock to find one who could recite pages of a school reading book from memory, or remember all the birthdays of the children in an institution or construct presentable objects out of wood, and so forth. To the psychologist, thinking in quantitative amounts of intelligence, it is no surprise to find individuals of mental ages from

seven to ten doing these or similar things, when he considers what a mentality of seven to ten can accomplish plus the results to be obtained by much practice, and making allowance for the presence of special abilities in limited amount among the feebleminded just as we find special abilities among the normal. All of the so-called idiots savants that it has been the privilege of the writer to see personally could readily be explained in this fashion. Those that are described in the literature are harder to account for, because we lack definite quantitative statements as to their intelligence level. One suspects in many cases that they were not technically feebleminded at all, being rather psychopathic or mildly insane types such as are to be found in most institutions for the feebleminded. The one case that has been described by Tredgold at length was certainly not feebleminded. This man was called 'The Genius of Earlswood Asylum,' and possessed remarkable skill in drawing and mechanical ability. He constructed elaborate models of ships and carried them out in the

FIGURE 7

MONGOL EYE: EPICANTHIC FOLD

(From K. Brousseau and H. G. Brainerd's *Mongolism.* By permission of the Williams and Wilkins Company, publishers.)

Case C

Case A

Case B

Case D

Case E

Case F

FIGURE 8

MICROCEPHALUS

(From M. W. Barr's *Mental Defectives*. By permission of P. Blakiston's Son & Co., Inc., publishers.)

Case A　　Case B (microcephalus)　　Case B

FIGURE 9

HYDROCEPHALUS AND MICROCEPHALUS

(From M. W. Barr's *Mental Defectives*. By permission of P. Blakiston's Son & Co., Inc., publishers.)

> greatest detail. We have no record of this individual's mental age. We know, however, that he was deaf and had a deaf brother, and that his parents were cousins. He never went to school and was, therefore, very uncouth and ignorant. In fact, he must have been like the average deaf child who has been allowed to run wild without training. He was sent to the institution at the age of fifteen and there he had the first opportunity to learn things. He was put to work in the carpenter's shop and as he made such excellent progress, he was given more and more opportunity to follow his interests. Tredgold himself says that he does not believe the man to have been 'intrinsically defective.' It would seem not. It would appear rather as if he were an untrained deaf child with more than average ability, all of which, owing to the circumstances and his own interest, was turned in one particular direction. It is somewhat misleading to group such cases under idiots savants. They are not idiots and they are far from being savants."

Since the above was written, the writer has found only three cases described by psychologists where intelligence tests are reported. One of these with a phenomenal memory, described by Jones (47), had an MA of 11-10 and an IQ of 85 (14-year basis), and therefore may be ruled out at once as certainly not feebleminded. Another, described by Otis (64), also had a phenomenal memory for dates, names, and places, but his MA on two Stanford-Binets is given as 12-11 and 13-0. This would mean an IQ of 92 or 93 (14-year basis). His MA's on other tests were generally lower, from 5-6 on the Porteus to 11-8 on language completion tests. Again this would not be considered a feebleminded case. We are thus reduced to the last case, described by Minogue (57), a 23-year-old boy with an MA ranging from 7-5 to 8-8 and an IQ from 53 to 62 (14-year basis). This case seems indubitably feebleminded. The boy is described as emotionally unstable. His special accomplishment is music, playing by sight and by ear. He plays very difficult pieces, and has a phenomenal memory. His father's family is described as very musical. Here, then, we would seem to have a moron with a special talent for music, concentrating all the intelligence he possesses in this one direction and achieving thereby much above the ordinary. But, on the whole, we must conclude that authentic cases of *idiots savants,* that is, feebleminded individuals with special talents, are very rare indeed.

Characteristics

Mental Development. The mental development of the feebleminded is not only slower than that of normal individuals, it also ceases earlier and begins to decline earlier. Kuhlmann (50) studied these factors by repeated examinations of 639 cases over a period of ten years. He found that during a year 4.8 per cent gained more than 12 months mental age; 68 per cent gained from 0 to 12 months mental age; 11 per cent made no gain, and 16 per cent actually lost in mental age. This tendency to deteriorate showed a marked relationship to degree of mental defect, the largest

percentage of those deteriorating being idiots and the smallest, morons. Similarly, Bonnis (11) in France, reporting on repeated retests of about 300 feebleminded cases, also found a tendency for the IQ to decrease, and Moore (59) in retests of 51 idiots reported that 35 showed a decrease in IQ, 9 an increase, and 7 remained the same. The median change in IQ was —.063 points per month.

As to qualitative differences in the mental make-up of feebleminded and normal children, many workers have suggested that such exist, but up to the present there seems to be no agreement on this point. It would seem rather that feebleminded children vary in their mental make-up qualitatively just as do normal children. The type of study made by Fox (33) may lead to the discovery of such differences if they exist. This worker compared normal and feebleminded children of the same mental age. By giving them four group tests he found the feebleminded to be weakest on subtests involving following directions, counting, relationships, comparisons, and discrimination of size. They were best on substitution tests.

As to whether the feebleminded are more uneven in the several mental abilities than normal children has been a matter of dispute among several workers. Brown (15) summarizes these divergent opinions, and his own work seems to show that the dull are no more uneven in mental ability

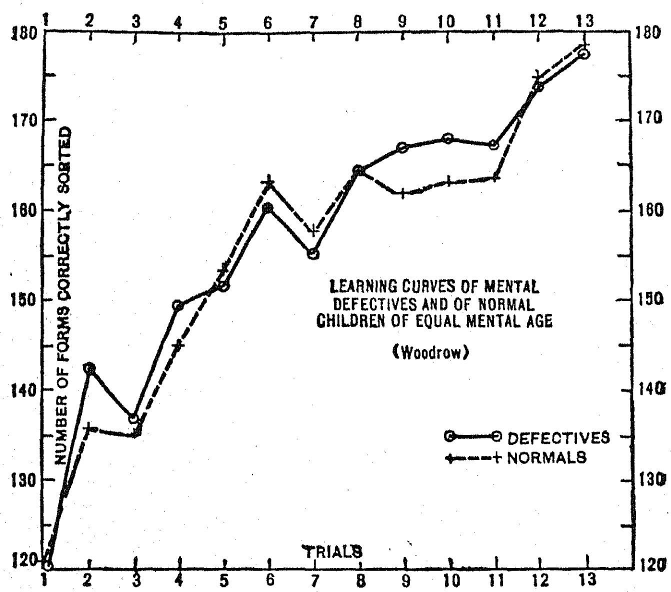

FIGURE 10

LEARNING CURVES OF NORMAL AND DEFECTIVE CHILDREN

(From H. Woodrow's "Practice and Transference in Normal and Feeble-minded Children," *J. Educ. Psychol.,* 1917, 8. By permission of Warwick & York, Inc., publishers.)

than are the normal, just as De Voss (24) found that the superior are no more uneven than are normal children.

With reference to learning ability in general, the work of Woodrow (91) shows that feebleminded and normal children of the same mental age have similar learning curves. Figure 10 shows the composite learning curves for two groups of children, feebleminded and normal, with an average mental age of nine years for each group. The learning consisted of thirteen days of practice in sorting five different kinds of geometrical forms into five different boxes. The average gross improvement and the percentage improvement for the two groups were the same, and we note from the figure that the general course of improvement for the thirteen days was practically identical. Similarly, Woodrow showed that the amount of transfer from this sorting of geometrical forms to sorting sticks and pegs and canceling forms and letters was also the same for his two groups.

In the recent German literature concerned with eidetic imagery, we find the suggestion made by Garfunkel (35) that there is a larger percentage of eidetikers among retarded children than among normal children. No comparison, however, between children of equal mental age is offered.

In summing up these studies of the mental characteristics of the feebleminded, one gets the impression that, taken as a group, they are very much like normal children of the same mental age. The mental development of the feebleminded is slower, but it does not differ qualitatively from the mental development of normal children.

Motor Development. In the motor development of the feebleminded we have the same picture of retarded development. Walking and talking are generally greatly delayed in making their appearance. Ley (53) compared normal and special-class school children in the same district and found that only 3 per cent of the normal, but 40 per cent of the retarded, had a history of delayed walking (not having walked before the age of two); and, similarly, with delayed talking (after the age of two), he found this to characterize only 2 per cent of the normal and 40 per cent of the mentally retarded. Wallin (88) gives the following average ages for normals and feebleminded:

	Normal		Feebleminded	
	Age in years	*N*	Age in years	*N*
Sitting unsupported	0.58	262	0.97	139
Standing unsupported	1.01	291	1.68	170
First steps unsupported	1.12	258	1.89	148
First walked unsupported	1.23	343	2.08	188
First used single words	1.06	278	2.07	164
First used phrases or sentences	1.73	267	3.04	157

In strength of grip and other similar motor functions, Doll (25) found the feebleminded in general below the normal. Hollingworth (42) sums up her discussion of these factors by saying:

> "The general conclusion from the studies of motor control in the feebleminded is, then, that they are inferior to children chosen at random. But, although inferior on the average, they approach much nearer the norms in motor ability than they do in intellectual ability."

Physical Development. Measurements of the height and weight of the feebleminded have been made by many writers (Wallin, 88; Doll, 25; Goddard, 37; Smith, 78; and others). They all agree in finding the feebleminded below the normal. In various physiological functions the feebleminded seem to mature more slowly. Thus Wallin (88) records the appearance of the first tooth for normals at 0.59 years, for feebleminded at 0.73 years; and the closing of the fontanelle for normals at 1.33 and for feebleminded at 1.76 years. But Popenoe (69*a*) finds the mean age of onset of first menstruation for feebleminded girls to be the same as that for normal girls. In general, this seems to fit into the picture of retarded development, both physically and mentally, although many writers believe that the physical development is not as greatly retarded as the mental.

With reference to the development of the head and the brain, in particular, most workers seem to be agreed that on the average the head circumference and the brain weight of the feebleminded are smaller than those of normal children. Porteus (70) emphasizes these differences, Tredgold (83) makes note of them, and Binet (7) concludes that head measurements are useless as indicators of amounts of intelligence. Evidently the feebleminded do not differ from the normal so much in size of head or amount of cerebral substance, as in the number of nerve cells in the brain, according to the research work of Hammarberg (40).

With reference to other physical factors the earlier writers on feeblemindedness, particularly the medical authorities, laid great stress on stigmata or physical anomalies. Tredgold (83) devotes about eight pages to these anomalies of anatomical development, mentioning in particular anomalies of the cranium, the palate, the teeth, the ear, the eye, the nose, lips and tongue. Hollingworth (42) describes the stigmata of degeneration in four pages, but adds:

> "It is necessary to emphasize again the fact that all stigmata mentioned here, and indeed all stigmata, may occur in human beings independently of mental status. *A diagnosis of mental deficiency cannot be made on the basis of stigmata.*"

Binet (8) made an extensive study of the physical signs of intelligence. In addition to head measurements, he studied dental irregularities, strabismus, malformations of the ear and palate, facial asymmetry, and speech defects. The hands and physiognomies of normal and abnormal children were compared. Describing this work, Peterson (65) says:

> "No important relations were found, and Binet says in conclusion that nothing is as deceiving as the physical appearance of intelligence, and that it is necessary to react consciously against our instinctive impressions in this regard."

TABLE 2
MORTALITY OF INSTITUTIONAL DEFICIENTS IN THE UNITED STATES COMPARED WITH THE GENERAL POPULATION
[From Miner (56)]

Ages	General population	Institutional feebleminded
5	1000	1000
10	983	795
15	972	696
20	956	606
25	934	503
30	903	428
35	872	349
40	835	290

Pintner (66) found a very low correlation between intelligence and estimates of this from photographs, and the pictures of two feebleminded children in the group of twelve were judged as normal or bright by many judges. Gaskill *et al.* (36) found a median correlation of .42 between intelligence and judgments of intelligence with twelve photographs of cases ranging in IQ from 18 to 171.

In concluding this section on the characteristics of the feebleminded, we may say that the general picture is one of slow or immature development. Mentally they are decidedly retarded but not qualitatively different from children of like mental age. In physical, motor, and sensory development, they are also retarded, but not nearly to the same extent as mentally. Physical anomalies tend to be more frequent among the feebleminded, but such anomalies do not differentiate them from normal individuals.

Lastly we may note the fact that this general all-round physical and mental retardation seems to bring with it a greater tendency to disease and a higher death-rate. In Table 2 we give Miner's (56) comparison between the mortality in institutions for the feebleminded as contrasted with the general population. Dayton's (22*a*) study of the mortality of 8976 institutional feebleminded in Massachusetts over a period of fourteen years shows a mortality-rate for idiots about five times, for imbeciles about two times, for morons only slightly higher than that of the general population. For all ages and all grades of these feebleminded in institutions the rate is two times that of the general population. The mortality-rate in institutions will, of course, be higher than that for all feebleminded in the United States because the most helpless will be found in institutions.

CAUSES

The great majority of feebleminded individuals are simply born that way. They occur in families where feeblemindedness or neuropathic conditions are common. No causal factor can be discovered. There may be secondary or aggravating factors, but not sufficient to cause feebleminded-

ness. We therefore say that feeblemindedness is inherited. The percentage of such inherited cases is put at about 90 by Hollingworth (42), and about 80 by Tredgold (83). Amentia caused by disease or accident is, therefore, a relatively minor consideration.

The evidence for the inheritance of feeblemindedness lies mainly in the investigations of the family histories of feebleminded cases. One of the earliest of such studies, which stimulated many later ones, is Dugdale's (29) report on the Jukes family. He traced seven generations of this degenerate stock, beginning with the progenitor, Max Jukes, born between the years 1720 and 1740. Crime, pauperism, and prostitution are the three outstanding traits of this family history, and Dugdale speaks of these three factors as if they were inherited. The modern student of feeblemindedness, however, sees in Dugdale's descriptions many evidences of feeblemindedness, and would be inclined to say that here was a feebleminded stock, unable to cope successfully with its surroundings, and therefore resorting to crime, beggary, and prostitution. Dugdale's work was published in 1877. In 1916 Estabrook (30) published a revision and continuation of Dugdale's work, bringing the family history down to 1915.

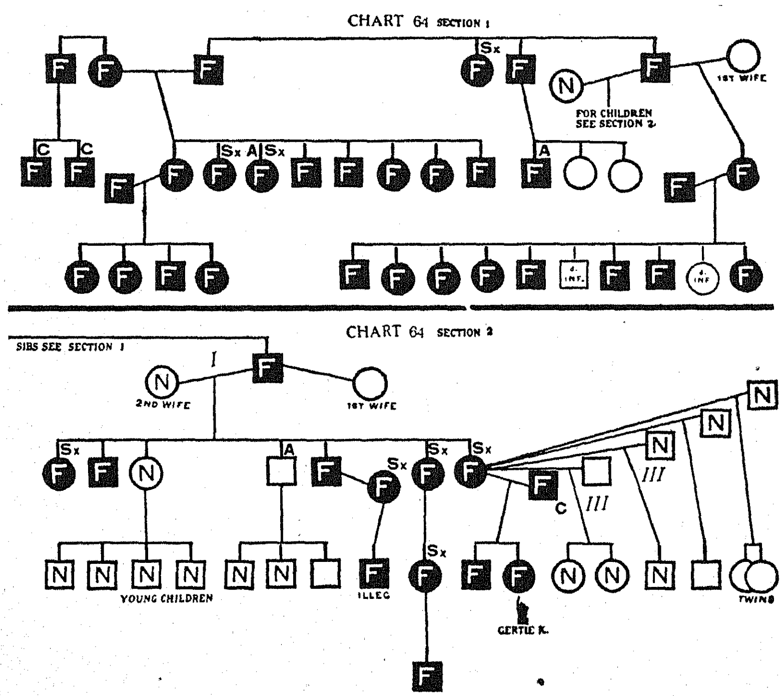

FIGURE 11

CASE 64. FAMILY HISTORY CHART SHOWING INHERITED FEEBLE-MINDEDNESS
(From H. H. Goddard's *Feeble-Mindedness.* By permission of The Macmillan Company, publishers.)

Dugdale's genealogy includes 709 persons, Estabrook's 2820. Estabrook estimates that 131 or 4.5 per cent were so feebleminded as to need custodial care. Of the 1258 descendants living in 1915 he estimates that 110 were mentally defective, 83 intemperate, and 171 industrious. Some members of the family had emigrated to a different section of the country, but the changed environment seemed to lead to no improvement so long as members of the old stock intermarried. Improvement of the old stock took place by out-breeding into better stocks. Estabrook is of the opinion that the outstanding characteristic of this family is feeblemindedness, although many members were not so feebleminded as to require custodial care.

The work of Dugdale stimulated many other family-history investigations. The most notable collection of family histories of feebleminded individuals has been published by Goddard (39). Altogether he presents about three hundred family histories, some of them very extensive. Figure 11 shows one of Goddard's genealogical trees. This family is characterized by a great number of feebleminded individuals. Figure 12 shows another chart where the only feebleminded case is the Mongolian child with whom the investigation began. Clearly this is not a case of inherited feeblemindedness.

Goddard sums up his results by saying:

> "One hundred sixty-four or 54 per cent of the 300 histories show other feebleminded persons in such numbers or in such relation to the individual case studied as to leave no doubt of the hereditary character of the mental defect. In these cases it is evident from the charts themselves that we are dealing with a condition of mind or brain which is transmitted as regularly and surely as color of hair or eyes. Thirty-four cases, 11.3 per cent have been grouped under the head of Probably Hereditary. The charts of these, while not

CHART 259

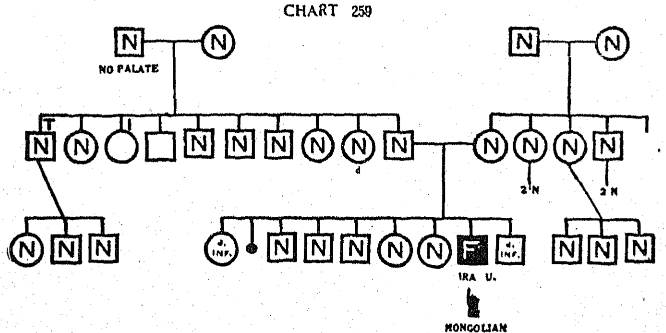

FIGURE 12

CASE 259. FAMILY HISTORY CHART SHOWING NO SIGN OF INHERITED FEEBLE-MINDEDNESS

(From H. H. Goddard's *Feeble-Mindedness.* By permission of The Macmillan Company, publishers.)

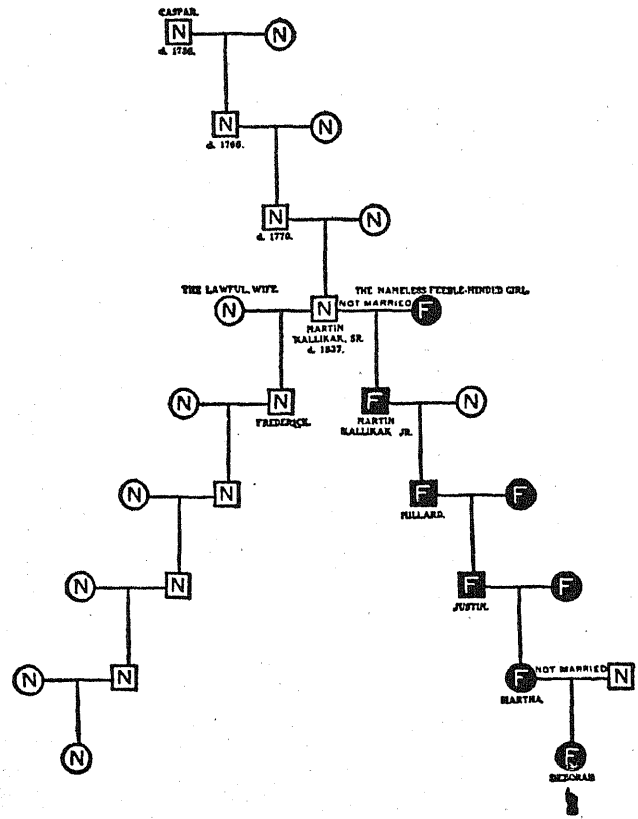

FIGURE 13

THE LEGITIMATE AND ILLEGITIMATE LINES OF THE KALLIKAK FAMILY

The black denotes feeblemindedness.

(From H. H. Goddard's *Feeble-Mindedness.* By permission of The Macmillan Company, publishers.)

> showing so certainly as in the former group the hereditary nature of the trouble, yet have a high degree of probability and may be considered hereditary."

An additional 12 per cent of the family histories show neuropathic ancestry. In all, therefore, we have about 77 per cent of the families showing hereditary mental defect. The remaining families show no hereditary taint, and the feeblemindedness of the child concerned is due either to disease or accident. The families in which feeblemindedness is hereditary naturally produce most of the feebleminded individuals, so that Hollingworth's estimate of 90 per cent, or Tredgold's estimate of 80 per cent, feeblemindedness caused by heredity may well be near the truth.

Goddard's (38) most remarkable family history is that of the Kallikak

family. He traced this family back to the time of the Revolution. Here we find the illegitimate mating of a normal man with a feebleminded woman leading to a long line of feebleminded individuals. A later, legitimate mating of the same man with a woman of superior intelligence leads to a long line of highly intelligent individuals. Figure 13 shows a synopsis of direct descendants of these two lines. In 1912 the illegitimate line showed 480 descendants among whom were 143 feebleminded, 36 illegitimates, 33 prostitutes, 24 alcoholics, 3 epileptics, and 3 criminals. The legitimate line showed 496 descendants, including doctors, lawyers, educators, judges, and business men. Only five were reported as showing bad traits, such as alcoholism, insanity, and immorality. There were no criminals. In addition to these studies of Goddard, there are many other family histories of feebleminded or degenerate families, such as "The Pineys" (48), "The Nams" (31), "The Hill Folk" (22), and the like. The evidence for the hereditary nature of the great mass of feeblemindedness seems conclusive.

The relatively small percentage of feeblemindedness caused by other than hereditary factors is due to several diseases and a few accidents. Glandular trouble causes cretinism and, perhaps, Mongolism. Encephalitis and meningitis may cause such ravages in the brain and nervous system as to leave the child mentally deficient thereafter. Epileptic attacks may be so severe or persistent as to prevent normal mental development. Congenital syphilis may attack the nervous system and prevent normal healthy growth. Hydrocephalus may be so pronounced as to injure the brain tissue. Birth injuries may sometimes lead to mental deficiency according to Doll *et al.* (27*a*). And, lastly, a severe accident to the head may injure the brain so markedly as to prevent or retard normal development, but such accidents must be very severe indeed in order to cause mental deficiency. The usual head injury does not cause feeblemindedness.

Treatment

There is no cure for feeblemindedness. The condition of the feebleminded cretin may be somewhat alleviated by glandular therapy, but no medical or surgical treatment has so far cured a case of feeblemindedness. Craniectomy to relieve the pressure on the brain has been tried and abandoned. Thousands of tonsils and adenoids have been extirpated in the hope of improving the mental faculties; teeth have been drilled and filled; hookworm and malaria have been eradicated; all kinds of diet and all brands of vitamines have been tried; but the feebleminded have come through it all—feebleminded. This does not mean that we should neglect the feebleminded child who suffers from enlarged tonsils or bad teeth. Certainly not. He should be looked after as well as his normal brother, but we should not make the mistake of hoping for a cure of his feeblemindedness by such means.

The treatment of feeblemindedness, therefore, lies in training. We must train the feebleminded child to make use of all the ability which he possesses. And we must begin as early as possible. It is stupid and futile to wait. The condition will not cure itself. We must abandon our superstitious belief in the magic seven, and cease to hope that the child will improve when he is seven or fourteen or twenty-one. Every clinical psychologist has met the pathetic case of the mother who reports that her doctor gave her reason to hope that the child would improve when he reached the age of seven. In this way many valuable years are lost because training should begin as early as possible.

The education of the feebleminded is carried on in special classes or in institutions. The special schools in general look after the less seriously retarded who can stay at home. The institutions look after the more seriously retarded cases and those who for one reason or another cannot be cared for at home. Witty and Beaman (90*a*) give a distribution of the IQ's of 11,950 children in special classes. The range in MA is from 2 to 15-7 years; the mean MA is 7-7, and the mean IQ is 63. How much formal academic work a feebleminded child can take depends very directly upon his intelligence level. The special class naturally attempts much more of this than does the institution. In most public school systems the special class contains cases above the moron grade of intelligence in addition to feebleminded children proper.

The governing principles of special teaching are set down by Descoeudres (23) as (*a*) utilization of the natural activity of the pupils; (*b*) the importance of sensory training and perceptual knowledge; (*c*) concentration and correlation of subject-matter; (*d*) individualization to suit the differing needs of the pupils; (*e*) practical utility for later life. Sense-training and handwork figure largely in Descoeudres' scheme. Whipple (90) emphasizes the importance of training for citizenship. In all special classes much emphasis is placed on practical work, such as cooking, sewing, manual and industrial arts, nature study, and the like. The aim is always to try to fit the boy or girl as well as possible for some place in society.

In institutions for the feebleminded the education is still more practical than in the special class. The lowest grades are trained as far as possible to take care of themselves, the higher grades are trained to help in the care of others and to help in the general work of the institution. Housework, gardening, and farm work of all kinds are suitable. Most of the feebleminded require a certain amount of supervision, but some become very steady and dependable workers. Some monotonous tasks are done excellently by feebleminded individuals. They are content to work daily at the same task, where an intelligent person would become bored and restless. Vanuxem (84) has made a careful study of the tasks suitable for feebleminded women. Her table is too long to quote here but samples are as follows:

Mental age	Time to learn	Capabilities
1 to 2	1 day	picking stones, trash from lawns, walks
2 to 3	3 days	weeding one kind of weed
	8 days	scrubbing
	16 trials	simple errands
3 to 4	3 days	picking one kind of fruit or vegetable
	8 days	sawing wood
4 to 5	7 days	simple hand-washing
5 to 6	19 trials	darning
	12 days	milking
6 to 7	31 days	fine hand-ironing
	15 trials	baking bread

Many other tasks have been studied by Vanuxem in an attempt to find out the capabilities of feebleminded adults. McGhie and MacPhee (53*a*) also give median MA's and IQ's for many occupations in an institution for the feebleminded.

The number of feebleminded individuals is so great that recently experiments have been made, notably by Bernstein (5), to fit the individual as soon as possible for his place in the community, so that he may make room in the institution for other cases. The individual is at first paroled from the institution until he more or less makes good. This method has been highly recommended by many authorities. The only thorough study of the results of this policy known to the writer is that by Town and Hill (82). They made a detailed investigation of 136 feebleminded persons who had been replaced in the community after residence in Rome State School during periods of a few weeks to thirteen years. This group of 136 included all the replacements in one county with the exception of twenty who could not be found. The question is how many of these 136 feebleminded people made good in the community. The answer is that only eight were found to have been independently self-supporting and law-abiding for the whole period since their discharge from the institution. Twenty-two, or 16 per cent, were practically self-supporting, but some of them had criminal records. In addition, twenty-seven others were partially self-supporting or self-supporting under supervision. If we include these, we have forty-nine, or 36.6 per cent, moderately successful, but many of these have had records of delinquency. Deducting the flagrant behavior cases, the authors conclude that 14 per cent "have made a fair adaptation to community life." If this report represents the usual consequence of returning the feebleminded to the community, we cannot hope for any great benefits from this method of treatment.

Since feeblemindedness is not a disease that we can hope to cure, what methods are to be adopted to lessen the enormous burden that feeblemindedness places upon the community? The only procedures seem to be training, segregation, and sterilization. Training all the feebleminded as much as possible is necessary so that they may be less of a liability to the community. The segregation of as many as possible is wise in order to diminish the chances of feebleminded offspring. The segregation of feebleminded

women of child-bearing age is particularly necessary. Sterilization is another means for preventing a further increase of feebleminded offspring. It has been adopted in a few states but is not extensively practiced. It is still opposed for legal and sentimental reasons. In all probability it will never be so extensively practiced as to reduce markedly the number of feebleminded. At present, therefore, segregation is the chief means adopted by society, and the number of feebleminded segregated is relatively so small that we may well doubt whether the percentage of feebleminded children being born is decreasing. Perhaps the percentage is increasing in view of the very noticeable modern trend among the more intelligent families to limit the number of offspring, with little corresponding limitation among the less intelligent families. It is, therefore, an open question as to whether or not the percentage of feeblemindedness in modern society is increasing. The recent (1929) British report suggests that it is.

Summary

In this brief chapter we have presented the chief facts about feeblemindedness from the standpoint of the psychologist. Let us review these briefly in order to get a composite picture. The history of the feebleminded is a long one, but only during the last one hundred years have they been scientifically studied and systematically cared for. The definition of feeblemindedness carries at present both sociological and psychological connotations. It emphasizes lack of mental development and inability to make good in society. More and more do our ideas of feeblemindedness seem to be influenced by the measurement of intelligence and the quantitative concept of a continuous distribution of general intelligence. Very rarely are diagnoses of feeblemindedness made without some intelligence test. As to where the upper limit should be drawn, conservative opinion would put it at IQ 60 and MA 8-6 (using age 14 as a basis for all IQ calculations above that age). Many, however, would include all below an IQ of 70 and an MA of 9-11. There are few authorities nowadays who would consider mentalities of 10 and 11 as definitely feebleminded. As to what percentage of the population are feebleminded, conservative opinion would say about 1 per cent for the whole country, with wide variations for particular regions. A more liberal opinion as to what constitutes feeblemindedness would easily raise this estimate to 2 or 3 per cent. There seems some reason to believe that there are more male than female feebleminded. The percentage of feebleminded among delinquents, paupers, orphans, deaf, and blind is higher than the normal percentage.

The feebleminded are generally classified according to degree of defect into idiots, imbeciles, and morons. A very small percentage present peculiar conditions and these are called clinical types. A very few individuals possessing some special ability are sometimes called *idiots savants*. The chief mental characteristic of the feebleminded is, of course, retarded mental development. He learns at the same rate as those of equal normal

development, but as he grows older he seems to show a decreasing IQ. He is not qualitatively different. In motor and physical characteristics he also shows the same retarded growth, but not to the same extent as in mental characteristics. He possesses more physical defects, is more subject to disease, and dies at an earlier age than his normal brother.

The chief cause of feeblemindedness is heredity. Numerous family histories support this contention. A very small proportion of cases is due to disease and accident. There is at present no cure. The care and control of the feebleminded consists of education, segregation, and sterilization.

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CHAPTER 21

THE CHILD OF SPECIAL GIFTS OR SPECIAL DEFICIENCIES

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INTRODUCTORY REMARKS

It is not the purpose of this chapter to cover the literature of controversy which has grown up around theories of the organization of intellect. The mathematics of correlation also lies outside our province. Such references as are here made to these matters are incidental to the task of surveying the researches which deal with concrete study of the abilities of persons. However, it may properly be noted in passing that new publications have recently appeared, which deal interestingly with theory and with mathematics (13*a*, 23*a*, 42*a*).

Our immediate purpose is to survey the literature of child study, as it originates in direct tests of children and adolescents, with a view to ascertaining what is known regarding those abilities, status in which cannot be predicted from a determination of general intelligence.

GENERAL INTELLIGENCE, *g*, OR IQ

It is now, on the whole, agreed among students of mental organization that positive but not perfect correlation is the rule among various mental functions. In other words, when an individual, child or adult, is tested over a wide range of mental tasks, there is found to be a personal quality which results in *generally* superior, mediocre, or inferior performances in his case, though the performances will not be likely to be all of equal merit. A coherence exists in the amounts of traits measured, extending even to appreciable coherence between mental and physical traits. This coherence or positive correlation has been called "the quality of the organism" (18). In so far as it relates to intellect alone, the terms "general intelligence," "*g*," and "IQ" have come into use (33, 42).

General intelligence is now measured, for practical purposes, by a variety of scales, all of which are based upon the fact of *positive though imperfect correlation* among performances, as regards amount (39, 41, 50). Binet was the first to apply this principle to the problem of classifying school children for purposes of education (5). He concluded, from reflection upon the research done, that failure or success in one mental function may be of slight significance for the classification of a child, because correlation has been proved to fall far short of unity (49); but that failure or success in a score of different functions must be of very great

significance, because correlation among mental functions tends strongly to be highly positive when correction for attenuation has been made and all other alienating factors have been avoided (40). Working on this theoretical basis, Binet devised a series of mental tests intended to sample a child's performance in many different acts.

Since 1904, various investigators (53, 27), particularly Terman (45), have improved upon Binet's method, and have devised the formula

Mental Age÷Chronological Age=Intelligence Quotient (*IQ*).

The IQ (discussed fully elsewhere in this volume) is the quantitative statement of the amount of general intelligence, or *g*, which characterizes any child.

It is, of course, true that these established facts about the relationship among mental functions are unwelcome to the popular mind. It would satisfy the longing for a "just nature" if we could believe compensation to be the rule among traits or functions. We long to hear that the child who is a good reader will be found lacking in capacity for arithmetic, and that the man of science is incompetent when it comes to financial dealings. To be told that excellence in one respect is predictive of excellence in nearly all other respects is offensive to the popular sense of justice and right. Thus we find here, as in so many other matters, antipathy between popular belief and scientific fact.

Specialized Traits[1]

It has been stated above that excellence in one respect is predictive of excellence in *nearly* all other respects—but not in absolutely all. It is the particular purpose of this chapter to mention certain functions which have been found least coherent with general intelligence, and to discuss these specialized performances in so far as may be feasible in the present state of knowledge. (One might better say, perhaps, in the present state of ignorance, since really we stand almost at the very beginning of investigation in these matters.)

We shall commence our discussion with two abilities which are of social-economic significance, and have been shown by quantitative research to be highly specialized. Musical ability and ability in representative drawing do not cohere significantly with general intelligence. Doubtless, other abilities may be found to be as highly specialized as the two mentioned. Perhaps ability to dance does not tell very reliably what to expect in mental work, generally. It is thought that ability to play chess may be rather highly specialized. Without doubt, each of these abilities is complex, made up of many elements, theoretically sharing in a special factor or factors affecting them as a group (26). However, limiting our discussion to facts based on the direct study of human beings, we shall proceed to consider

[1]For a definition of such terms as "trait," "function," "capacity," "ability," "talent," see Hollingworth (21).

ability in music and in representative drawing as very definitely dissociated from *g*.

Musical Ability. There are many different kinds of music, requiring different kinds of psychophysical equipment for their execution, severally. For instance, singing requires endowment which may well be lacking in a highly gifted pianist. A violinist must show characteristics which are possibly dispensable in the case of an organist. To sing, to play the flute, to play the guitar, to compose a symphony—these are by no means all necessarily possible to the same person.

Since about the year 1915, psychologists have turned to the investigation of the musical person. This led immediately to analysis of musical talent, for it soon became evident that very many elementary functions are involved in any kind of musical performance. These various functions may be roughly classified under three categories: (*a*) *the acoustic functions,* the capacities involved in perceiving musical sounds, (*b*) *the motor functions,* those involved in executing musical sounds, and (*c*) *the intellectual functions,* which enable the interpretation of musical compositions and the origination of new ideas (38).

Two of the most important and fruitful of analyses attempted are those of Révész (34) and of Seashore (38). Révész studied children who were extremely gifted in music and proposed that in analyzing musical talent the following functions must be considered: (*a*) composing, (*b*) reproducing, (*c*) hearing, (*d*) remembering musical elements, (*e*) transposing, (*f*) improvising, (*g*) modulating, and (*h*) playing at sight. Later, in 1920, Révész proposed eight tests devised for the identification of the musical. These were for sense of rhythm, absolute pitch, octave recognition and transposition, relative pitch, harmony, memory of a melody, and playing by ear.

The most complete inventory of musical talent so far proposed is that of Seashore (38) which cannot be given in detail here. It includes musical sensitivity, musical action, musical memory, musical intellect, and musical feeling. Seashore's greatest contribution in this field has been the invention and standardization of scales for the quantitative determination of five of the basic elements in musical sensitivity, and for one element in musical memory. These are for pitch, intensity, time, consonance, rhythm, and tonal memory. They have been made available through the medium of the phonograph and are being applied to the study of musical talent.

Correlation has proved that these various elements in musical sensitivity are to a large degree independent variables. Persons may rate high in some and low in others. Sense of pitch and sense of time are, for example, not closely related. Excellence in one may coexist with deficiency in the other. The outstanding musician will be he who combines these totally or partially uncorrelated elements in high degrees of excellence in each. The majority of children combine the elements in moderate or typical amounts, and are therefore able to learn music and appreciate it in the

ordinary manner only. There exist but a few children who are capable of distinction as professional musicians. Schussler (36) concluded that from 5 to 10 per cent of the school children examined by him might be fairly classified as unmusical. A similar percentage could doubtless be classified as very musical, and of these a small proportion would be capable of outstanding musical achievement.

The fact that superior musical talent may coexist with mediocre or inferior intelligence (as well as with superior intelligence) sometimes leads to marked discrepancies among teachers' judgments of pupils. The special teacher of music may, in a given case, estimate a child as "brilliant," while the classroom teacher rates him or her as "deficient." Obviously, the opposite situation may as frequently occur. For example, Coy (11) cites the case of a boy recommended as eligible to a special class for intellectually gifted children "because he could play the ukulele and sing." This boy was proved by tests and by achievement under instruction to be far from the intellectual standards set for inclusion in the group, although gifted in music. Measurements of musical sensitivity made on a group of children all testing in the highest centile for intellect gave no better results than are found for the total generality of school children of like age (23). Minogue (31) has reported in detail the case of a boy detained in a state school for mental defectives, who showed gifts in music far beyond those usually possessed by persons of superior intelligence. Such studies are multiplying, and they show us that we cannot predict musical ability from the results of general intelligence tests, or general intelligence from musical ability.

Tests show that musical abilities are highly specialized, but this is not to say that distinction in music can be achieved by the stupid and dull. The achievement of eminence in any branch of endeavor calls for a grasp of life-situations and a foresighted fidelity to remote goals, which are functions of general intelligence. Thus the investment of large sums of time and money in the musical education of children who have special talent, but who rate low in *g*, is of doubtful wisdom, if eminence is in question. However, not very much is as yet known with certainty regarding these practical questions.

Musical gifts reveal themselves early in childhood. Eminence has been rather frequently won in musical careers before the age of sixteen years. Prodigies like Mozart show their ability as early as four or five years of age by playing upon musical instruments. On the other hand, deficiencies such as tone-deafness are not so likely to be discovered at an early age. Usually they are first revealed when the child attends school or when attempts are otherwise made to educate him musically.

The tests standardized by Seashore cannot be applied until *mental age* is about ten. This is because the directions for taking the tests must be comprehended, and, as they are too complex for the intelligence of children younger than ten years, the musical sensitivity of those younger cannot be measured except in the case of exceptionally intelligent children.

Ability in Drawing. Drawings may be classified into various kinds, according to the technique employed and the meaning conveyed. These kinds are (*a*) representative, (*b*) analytical or diagrammatic, (*c*) impressionistic, (*d*) symbolic, (*e*) caricature, and (*f*) copying. This classification is exclusive of other forms of graphic or representative expression, such as painting, sculpture, and the cutting of silhouettes.

These various forms of art differ as to the psychophysical equipment constituting talent for them. In some kinds, as in caricature and symbolic drawing, there is probably a large admixture of *g*. Our attention is here centered upon simple *representative drawing*, such as may result from looking at an object and trying to reproduce it, with visual realism, on paper or some other appropriate material. It is this kind of art that has been shown to be markedly independent of a person's general intelligence.

When we think of drawing as prescribed for children at school, there is a tendency to consider only those performances which are done during the time set aside for instruction by the teacher of art. But a little reflection will show us that drawing occurs in connection with a variety of school subjects. In sciences taught by the laboratory method drawing is an important factor in success. Zoölogy, physics, and botany are especially taught through drawing. Map-drawing is required in geography. In nature study notebooks for the drawing of natural objects are often kept. Thus it happens that school marks in these subjects depend in part on this specialized ability. It was contemplation of the possible difficulties of appraisal which might arise in requiring general intelligence to express itself through the medium of a special ability that caused Ayer (1) to undertake his valuable researches into drawing as a medium of expression and to bring together the literature of this subject which existed previous to 1916.

Ayer's investigation was planned to determine how two kinds of drawing, representative drawing and analytical drawing, might be related to (*a*) ability to describe in words and (*b*) achievement in school subjects.

A turkey feather was used as the object of investigation. Ayer had fifty-one high-school pupils draw the feather representatively, draw it analytically (showing its structural relations), and describe it verbally. He found the correlation between representative drawing and verbal description to be practically zero. From knowledge of ability in one of these functions, no inference could be made concerning the other. The results of analytical drawing (diagramming) cohere slightly with those of verbal description, but not with the results of representative drawing. Finally, Ayer correlated the scores made by the fifty-one high-school pupils in representative drawing of the turkey feather with their school marks as a whole, and found that one could not be inferred or predicted from the other.

Other investigators (12, 13, 25) have obtained the same results as those of Ayer. No contradictory findings have been reported. Ability in representative art is a special gift, but, here again, this does not mean that a

person deficient in *g* may look forward to a distinguished career in the arts. As Manuel (29) says:

> "Before one gets very far in art expression, a great number of supplementary factors must be brought to the support of the ability to represent graphically simple objects. Even the technique itself becomes progressively more difficult. . . . . General intelligence conditions the ability. . . . . (*a*) to acquire the advanced technique into which conceptual factors enter, and (*b*) to create original drawings of merit."

There have been various attempts to analyze into its elements the ability to draw. It is agreed that the ability is complex, but it cannot be so easily taken apart as can musical ability. Like general intelligence, it is distributed among children in various degrees, most having a moderate or "normal" amount. The superior degrees constitute *talent*. Modern life calls for all forms of talent in drawing in combination with various degrees of intelligence. Sign-painters, copyists, designers, architects, illustrators, and creative interpreters are all needed. Persons talented in drawing are essential to mechanical and industrial development, for everything manufactured—from a suspension bridge to a bird cage—must first be drawn or designed.

It is thought that talent in drawing probably manifests itself typically at an early age. However, until methods of measuring and identifying this talent shall have been developed, we cannot discuss its manifestations in childhood, as would be desirable for the better education of children.

Carroll (8*a*) and Carroll and Eurich (8*b*) have made studies of art appreciation, including various art forms. Using the Meier-Seashore Art Judgment Test, the Hevner Music Appreciation Test, and the Carroll Prose Appreciation Test as instruments of research, "the data gathered indicate strongly that the relationship existing among the capacities to appreciate art, literature and music is very slight. Literature and art show a somewhat greater tendency to vary together than do literature and music or art and music."

The McAdory Art Test given to dull children (mean IQ 71) and to intellectually gifted children (mean IQ 132) showed a considerable overlapping between the two groups in art appreciation. No bright child fell below the mean of the dull group, but 9 per cent of the dull group exceeded the mean of the intellectually gifted. The inference is that considerable ability in art appreciation is more likely to appear in a dull child than is a serious deficiency in a bright child.

Reading and Spelling. According to Meumann (30), the whole field of language is a special unit, psychologically considered. This view of the close coherence among various linguistic functions, is borne out by the work of Gates (15), in which high positive correlations were found among perceptual tests which use words as materials, in comparison with those which do not involve words. Furthermore, Schneck (35) has proved a specialized unity to exist among linguistic functions.

Whereas music and drawing have been more frequently approached from the side of conspicuous talent, reading, spelling, and arithmetic have been more often studied from the standpoint of specialized deficiency. Most of the case studies in this field are of children who were especially poor readers, spellers, or arithmeticians.

Furthermore, it is true that these groups of functions are not uncorrelated with *g* to anything like the same extent as are ability in music and in drawing. The positive correlation between measurements of IQ and of ability to read is close. It does not, however, reach unity; so that rarely a marked discrepancy between general intelligence and ability to read may be found among children.

Moreover, it is of value to distinguish in this connection between the *mechanics* of reading and the *comprehension* of materials read. There is a closer correspondence between IQ and reading for comprehension than between IQ and reading for pronunciation or speed.

On the whole, it may be stated, as a result of the study of poor readers, that when a child fails to learn reading in accordance with expectations from *g* the discrepancy is found to be due not to any genuine lack of gift, but either to poor habit formation, which can be corrected, or to sensory defects of eye or ear (16).

Examination of the special senses is the first step dictated by common sense and scientific procedure when an intelligent child fails in reading. For this reason it has happened historically that the first cases of special failure in reading and spelling among school children have been reported by ophthalmologists, who have originated the term "word blindness" (32). Parents naturally sought the expert who knows eyes in such cases, for, to one unversed in the psychology of reading, it appears that reading is done exclusively with the eyes. However, defects of hearing must also be considered. The correct sound of a word is essential in learning, as well as the correct visual form.

Whether there are cases of "word blindness," in the sense of special defect in aptitude for reading, aside from those covered by faulty habit formation and by sensory defects, remains in dispute. If aptitude in reading is really due to a rather highly specialized group of functions, then we should expect to find children deficient or mediocre in *g* who are, nevertheless, remarkably good readers. We do not seem to find such cases; but a few instances have been reported from time to time of children rating very high in general intelligence whose ability to read exceeds expectations from IQ. Such a case is that of Martha, reported by Terman (46).

Martha was seen by Terman when she was two years old; at that time she read fluently from an ordinary primer. The method and amount of instruction which led to this remarkable result are set forth in the account. Expectation from reading alone would place Martha's IQ somewhere near 300, for she read what a typical child of three times her age can read.

Later Terman tested the general intelligence of this child, and obtained a rating of 150 IQ (Stanford-Binet). Thus Martha's phenomenal ability to read must be considered special in the sense that her IQ fell far short of expectation therefrom. Other similar cases have been reported in the literature of child study (3, 14).

In the case of spelling, the correspondence with general intelligence is not so close as with reading. It is easier to find bright children who are poor spellers than to find bright children who are poor readers, and easier to find dull children who spell relatively well than to find dull children who read well (21). Here again, excellent spellers have not been well studied, but disability in spelling has received a considerable amount of attention (7, 20, 52).

Spelling is a very complex function, involving many interconnections among the various special senses, together with much cooperation of *g*. Poor spelling, like poor reading, may be due to sensory defects, either of the ear or of the eye. If sounds are indistinct, or if visual symbols are vague or distorted, the prescribed connections involving these elements will be difficult to form. Thus, tests of auditory and visual acuity must be given to a poor speller to determine whether any sensory defect may account for failure.

Since correlations with general intelligence are quite high, the degree of general intelligence of a poor speller must be found. Failure to learn to spell is very frequently symptomatic of deficiency in *g*—though not so frequently as in the case of reading.

Poor habit formation accounts for a large group of poor spellers. Pronunciation may be defective, handwriting may be awkward, or habits acquired in connection with a foreign language may interfere with spelling. Moreover, temperamental traits, such as instability, laziness, distaste for drill, may be the cause of failure in spelling (15, 19).

Studies of attempts to improve poor spellers show that this can be done by drill, carried out by looking at the word analytically, pronouncing it analytically, writing it repeatedly, and, to some extent, by learning general rules which govern the sequences of letters. Bright children are prone to errors arising from generalization which is misplaced, though they make far fewer errors, on the whole, than are made by dull children (8).

Since we know the thousand most commonly written English words (2), a device of merit in training a poor speller is to teach, first of all, these thousand words. By mastery of the thousand words most frequently written, more errors will be eliminated from a child's spelling than by mastery of several thousands of less commonly used words. To master the spelling of *to, too,* and *two* will eliminate hundreds of errors, where to master *caste*, *subtle*, and *dungeon* will eliminate but three (or possibly none).

The few non-readers and non-spellers who grade above 80 IQ are potentially literate and worthy of special attention at school, since their

general intelligence is such that they will suffer a special handicap from illiteracy.

Arithmetic. Correlations show that capacity for arithmetic is closely connected with general intelligence. Most of the children who fail in arithmetic do so as a symptom of general lack of competence in thinking. The great majority of those who excel in dealing with numbers are superior also in other mental work.

Here, again, we are dealing with a very complex set of functions. Thorndike (48) expresses this fact as follows:

> "Achievement in arithmetic depends upon a number of different abilities. For example, accuracy in copying numbers depends upon eyesight, ability to perceive visual details, and short-term memory for these. Long column addition depends chiefly upon great strength of the addition combinations, especially in higher decades, 'carrying' and keeping one's place in the column. The solution of problems framed in words requires understanding of language, the analysis of the situation described into its elements, the selection of the right elements for use at each step, and their use in the right relations."

Generally speaking, special deficiency in arithmetic in a child of good IQ is the result of failure to build up the necessary hierarchy of habits and can be overcome by formation of the right habits. However, tests seem to show that the abilities involved in computation form a somewhat specialized unit. In 1910, Brown (6) determined from correlations that there is an especially close relationship among tests involving mathematical performance. Ten years later, Collar (10) made an effort to secure further data as to whether arithmetical ability, as a unitary group of capacities, exists. Two hundred school boys were tested. Results led to the conclusion that arithmetical ability tends to be represented in two main divisions: (*a*) the power to compute with ease and readiness, and (*b*) the power to solve problems by arithmetic, which involves the application of a higher degree of ability than is required in computation. Arithmetical tests of various kinds correlate more closely than do arithmetical with non-arithmetical tests. "Hence we are compelled to interpret this relationship as evidence distinctly in favor of Burt's suggestion, that there is an essential unity in arithmetical ability."

Also, Thorndike and his students (48) have shown that, in general, the correlation between ability in any one important feature of computation and ability in any other important feature of computation is positive and high. Nevertheless, these abilities are not perfectly correlated; and so it is possible to find children who are specially apt or inept in a single process, such as subtraction, multiplication, or division.

"Lightning calculators," so called, have attracted some attention from students in this field (4, 28, 37). All who have examined these arithmetical prodigies, or have searched their records, are agreed that the secret of their excellence lies in highly developed mechanics. Special *habits* of

combining and recognizing numbers are formed which differ from ordinary calculation in somewhat the same way as adding 7+5 differs from adding 7+2+2+1. The lightning calculator memorizes combinations far beyond those ordinarily memorized, so that he is, for instance, able to add 6745+9632 as quickly as the ordinary person can add 13+8. He learns multiplication tables up to 100×100. He devises and uses "short cuts." Multiplication is probably used as the fundamental operation.

Drill is the means for improving arithmetical ability, in so far as speed and accuracy of calculation are concerned. Ability in problems can probably not be greatly affected by drill, since "a problem" is, by definition, something that requires adjustment and not the response of automatic habit. It therefore calls on general intelligence and cannot be improved after the mechanics of reading and of calculation have been mastered up to the limits of capacity. Engelhart (12*a*), observing fifth-grade pupils, and using a "path-coefficient technique," has found about 25 per cent of the variance in problem-solving to be due to variation in intelligence as measured, about 42 per cent to be due to variation in computation ability, a very small amount to be traceable to variation in reading, while about 33 per cent is found due to the influence of undetermined causes.

Mechanical Ability. In 1915, Stenquist, Thorndike, and Trabue (44) tested dependent children in a county of New York State. They used tests of various kinds, including a test of ability to put simple dismembered mechanisms together. Correlating the results of this test with those of others, they found it to be rather widely dissociated from *g*. Though not nearly so completely unrelated to general intelligence as are musical ability and ability to draw, this ability to assemble simple mechanisms is by no means always found in large measure in bright children, while dull children sometimes succeed well at it.

Subsequently, one of these investigators, Stenquist (43), made more extensive tests, and standardized a measuring scale to gauge mechanical aptitude. With improved methods, it was again demonstrated that ability to assemble mechanisms is not very reliably predictable from status in general intelligence. The chances are, however, that a child who is superior in *g* will score higher in mechanical aptitude than will a dull child.

More recently McElwee (29*a*) has calculated the percentage of overlapping in tests of mechanical ability among three groups of pupils differing widely on the basis of general intelligence tests. The results show that these groups distribute very similarly in mechanical ability. However, when groups were selected which did not overlap in mechanical ability, these groups yielded more high scores in reading among pupils in the high group for mechanical ability than in the other two groups.

Great inventors of mechanical devices are doubtless, as a group, very far above the average in general intelligence. This statement cannot be advanced with positive certainty, as the *g* of a large number of inventors has never been measured. The idea is deduced from the fact that invention

evidently calls for a high degree of selective thinking and of interest in problems. Even so-called "invention by accident" calls for a high degree of ability to "notice" a new element in the familiar situation in relation to other elements.

In comparing the mechanical aptitude of bright and dull children, it is essential that age be kept constant. This fact is emphasized here because a number of unsound inferences have originated from comparisons of groups of unlike age in "performance tests" which involve handling concrete objects as in the tests of mechanical aptitude. Feebleminded adults, for instance, do appreciably better (achieve a higher mental age) on performance tests than they do on general intelligence tests which omit manipulation (51). On the other hand, very young children who are intellectually gifted achieve a comparatively low mental age on tests involving the hand.

At times the facts just stated have been interpreted to mean that there are various kinds of intelligence, one kind measurable, for instance, by tests involving verbal symbols, another measurable by the manipulation of concrete materials. The truth is that the participation of *hand, wrist, and arm* in the so-called performance tests is the chief factor producing this discrepancy in results. These members of the anatomy give greater advantage, the *older* the person being tested (up to the point of maturity). Thus it is clear that old-dull subjects will do relatively well on performance tests, while the young-bright will do relatively poorly, since, in the process of standardization of the performance tests, the eight-year "mental age," for example, was determined in large part by eight-year-old hands, wrists, and arms; but this was not true of the standardization of a scale like the Stanford-Binet.

Recently, Carter (9) has concluded that there is no general factor of mechanical ability, and also that mechanical abilities are not completely specific. The probability is suggested that there are group factors in mechanical tests which overlap from one to another. These conclusions rest upon a statistical analysis of the Minnesota Mechanical Ability Tests as applied to boys in the junior high school. Using the same series of tests, Hubbard (24) has found that mechanical *interests* are but slightly related to mechanical *abilities*.

Ability to Lead and Govern People. It has been suggested that ability to deal with human relationships is specialized, in the sense that it is not closely related to *g*. Very few quantitative studies of the matter have been undertaken. In the first place, "ability to deal with people" has not yet been reduced to quantitative terms. Terman (47) and others have given us a few facts from studies of children rating high in *g* which tend to indicate the relation between general intelligence and leadership in childhood. According to teachers' judgments, children rating above 120 IQ are much oftener leaders than chance would allow, and they are usually liked by other children, even when not designated leaders. Few children above 120 IQ are judged by teachers to be unpopular. Partridge (32*a*)

gave adolescent boys opportunity to choose leaders, under experimentally controlled conditions, and found that those chosen tended to rank well above the average of the group in scores on Army Alpha, with age eliminated as a factor in scoring.

From observation of the frequency with which children rating high in *g* become leaders of other children, the present writer is led to believe that there is an *optimum* range of IQ, within which popular leadership is frequent, but above which it is very improbable. This optimum range is in direct dependence upon the general intelligence of the led. For groups of children having IQ's of close to 100, the optimum range for popular leadership seems to fall between 110 and 130 IQ. Children who rate above 160 IQ appear to have small chance to lead their fellow children when the median IQ of the led is 100 or lower. Children of IQ over 180 have practically no chance, in the observation of the present writer (22), to become popular leaders.

Why should too much intelligence militate against the attainment of popular leadership? It is clear that, in order to organize and lead others, there must be mutual comprehension between the leader and the led. There must also be a certain community of interests. The child rating above 160 IQ tends to fall well above the optimum range for leadership in groups of unselected children because their interests are not his and because his vocabulary is beyond their comprehension. He is not interested in mumble-the-peg. They are not interested in the solar system. Only in very highly selected groups can a child rating very high in *g* achieve leadership, that is to say, in groups which intellectually approximate his own IQ.

Too much intelligence thus tends to disqualify a child (or an adult) for popular leadership. On the other hand, too little intelligence also undoubtedly tends to disqualify. It will be an interesting problem to determine experimentally just what may be the optimum range of general intelligence within which popular leadership of typical persons is achieved. "Social intelligence" is, in all probability, not a specialized set of mental functions, but merely an optimum section of the curve for *g* (determined by ratio to the median intelligence of the led), combined with certain physical and temperamental traits.

These traits of physique and of temperament are of first-rate importance. The flighty, the depressed, the self-centered, the shy, are not well suited to organize and lead. Likewise, the shrill of voice, the shabby, the small, are handicapped by these characteristics.

Facility in leading people is due, therefore, to total personality, mental and physical, of which *g* is an element. Correlations between popular leadership and general intelligence will thus be still further reduced from unity, because temperament and physique are far from highly correlated with intelligence.

General Considerations

The question arises: Can special talents be acquired, or can special defects be overcome, by any course of training? Educational psychology tends more and more strongly to the conclusion that training can do little or nothing to alter the amounts or relationships of mental endowment. We can but measure endowment and give training suited to its requirements. Education cannot bestow mental gifts, either general or special. Talent and genius can be created in children only by the procreation of parents who are the biological carriers of extraordinary endowment.

Why should certain capacities for performance, like musical aptitude, be so loosely related to general ability throughout our species? We do not know the answers to such questions as this. The suggestion arises that perhaps those performances which do not cohere closely with performances in general are activities which involve the sensorimotor apparatus to a marked degree rather than the central nervous system. It would be valuable to determine whether, as performances involve ever more and more of the bodily members, they yield ever lower correlations with capacity for using abstract symbols and for relational and selective thinking (at present measured by our tests of general intelligence). Certainly, drawing involves eye, hand, arm, and wrist in a manner not required for the detection of absurdities or the giving of opposites. Undoubtedly, musical sensitivity involves specialized structures of the ear in a way not held in common with the perception of an analogy or of the meaning of a word. The mechanics of reading clearly depends upon the sensorimotor apparatus much more intimately than does comprehension of what is read.

These and many other problems, such as the question of the neural basis of specialized functions, wait upon further investigation. A chief criticism of our times is that too much work upon these problems is being done with paper and adding machines, and too little with human beings. It is, after all, not the characteristics of statistical formulae that are sought, but the characteristics of children. To study children directly is arduous and exhausting work, involving tedious contact with parental prejudices, chicken-pox and measles, temper tantrums, irrational negativisms, and a host of other irritations inseparable from children in the concrete. Study of the adding machine is devoid of all these ills, but it is questionable whether the latter can be successfully substituted for the former. The classics in the field of child study have resulted from the work of Darwin, Shinn, Binet, Terman, and others who have not shirked the difficulties of direct contact with children themselves.

In the meantime, even such knowledge as we have accumulated is of value for the welfare of children, who, save for application of this knowledge, would be compelled to attend upon prescribed education, without regard to the idiosyncrasies of original endowment.

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CHAPTER 22

THE CHILD WITH DIFFICULTIES OF ADJUSTMENT

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INTRODUCTION

Since the beginning of the scientific interest in child study, we have been steadily accumulating data concerning the physical and mental growth of the child and many other aspects of child development. Particularly relevant for the present topic, since we are to discuss maladjustments other than those due primarily to mental deficiency or serious physical defects and diseases, are studies of emotional growth and of the formation of personality and behavior patterns. Equally important is the concept of childhood as a period in which there is continual effort to comply with the social control exerted by adults and to adjust to environmental situations which are constantly changing and becoming more complex. For example, the child must gradually learn to control hunger and the eliminative processes until habits in accord with conventional standards are formed, and to express emotions in certain limited and socially acceptable ways. He goes from the home to the school, where he is expected to adapt to group relationships with other children and to conform to classroom routine and regulations.

As Aichhorn (2) and Glueck (23) have remarked, the very multiplicity of adaptations required creates the possibility that not all of them will be accomplished successfully, so that there is always a chance for developmental and adjustment difficulties to occur. The inherited and congenital characteristics of the child are partial factors in determining what will happen in his development and adjustment, but the environment also may be unfavorable for emotional growth and for the formation of desirable personality and behavior patterns. There may exist situations to which not even the most adequately endowed individual could adjust in any satisfactory fashion.

CRITERIA OF ADJUSTMENT

One of the first questions which confronts us is that of criteria whereby we may distinguish between so-called "normal" and "problem" children. In two instances—when juvenile delinquents and psychotic children are considered—the symptoms of maladjustment are so pronounced that this question may not arise. But when we come to the wide variety of childhood difficulties that appear in patients referred to mental hygiene clinics for children, differentiation becomes a more complex matter. In the re-

ports from such clinics (9, 18), we find children described in terms of undesirable personality and behavior patterns, "nervous" habits, psychoneurotic symptoms, faulty habits of eating, sleeping, and elimination, and the like.

Many of these phenomena occur to some extent with almost any child as well as with clinic patients, and, according to some observations on child development, are normally to be expected at certain ages. Olson (33) and Wickman (44), to quote two representative studies, found that a large number of the undesirable behavior patterns listed for "problem" children are also found among unselected school children. Olson's investigations suggest that this is true not only of behavior but also with respect to "nervous" habits (32). The psychoanalytic approach to child development (20, 24, 35) would consider that many habits and many personality and behavior traits frequently classed as undesirable are natural manifestations in one or another of the early stages of psychosexual development in the preschool years. For example, thumb-sucking and other oral habits are characteristics of the oral phase of psychosexuality in the first twelve or eighteen months of life. Cruelty and destructiveness are an accompaniment of the anal-sadistic phase during the second and third years, while jealousy, marked emotional ambivalence, sex curiosity, and sex play are likely to appear in the fourth and fifth years when the genital and Oedipus stages are dominant.

The statistical researches of Wickman (44) and Olson (32, 33) indicate that the frequency with which a given undesirable trait appears in the child or the number of undesirable patterns shown by a single individual are partial criteria for differentiating between adjustment and maladjustment. The psychoanalytic studies imply that persistence of the habits and behavior characteristics of an earlier stage into later stages or into the latency period is significant; also that regression to earlier patterns of response is likely to be a sign of adjustment difficulties.

There is some lack of agreement, among different groups of adults associated with children, concerning criteria of adjustment. Wickman (44) found that teachers were of the opinion that behavior disturbing to the classroom routine and discipline was indicative of serious maladjustment but were not so apt to think of withdrawal from social activities and retreat into day-dreams as being very serious. Professional workers in children's clinics, on the other hand, regarded the latter as more serious than the former. Similar differences of opinion between mental hygiene workers and parents have been reported by Stodgill (41).

From these varied studies of the question of adjustment versus maladjustment, we may at least conclude that both terms must be used with a qualified meaning to describe differences in degree rather than in kind. From the practical clinical viewpoint, the degree of adjustment or maladjustment must be estimated, in any given case, on the basis of the child's age, intellectual abilities, developmental history, and the whole environmental setting. Only in the light of such facts can we judge whether the

child is in need of treatment or whether, given more favorable conditions in which to live, he would be able to work out suitable adjustments.

Juvenile Delinquency

In this country, the clinical approach to the study of the juvenile delinquent began in 1909 with Healy's work in Chicago. Since then there has been considerable scientific investigation in this field. The data now available from various sources are too well known to need more than brief comment. It is interesting, however, to note the distinct change from emphasis upon constitutional factors and marked mental abnormalities as causes of misconduct to increasing stress upon developmental difficulties and unfavorable environmental situations in relation to delinquent behavior.

The work of Healy and Bronner (26) in this country and of Burt (13) in England are excellent samples of the clinical studies of juvenile delinquency. The former reports data from 4000 cases; the latter includes only 200 delinquents, but the findings are checked against those for a group of non-delinquent controls. Both investigations indicate that such conditions as broken homes, parental neglect, poor discipline, and influence of delinquent associates are of frequent occurrence in the environment of delinquent children. In Burt's study, they are found far more frequently in the delinquent than in the control group. Both studies indicate that heredity, in the sense of the child's having delinquent relatives, cannot be considered very significant; it is particularly noted, in the Healy and Bronner cases, that treatment was as successful for those having delinquent relatives as for those where the relatives were non-delinquent. Attendance at movies, so often popularly advanced as contributing largely to juvenile delinquency, rarely has much effect upon the child's development of antisocial behavior patterns, according to these clinical studies.

Poverty was a part of the environmental background for a relatively small proportion of the Healy and Bronner cases. In Burt's, it appears in more than half of the delinquent group but in nearly as large a number of the non-delinquent controls. Thus both investigations minimize the importance of this factor in the production of delinquency. But we have yet to see what the recent increase in juvenile vagabondage, during the last two years of extreme economic depression, will mean in future terms of juvenile delinquency, although it suggests that there may be a relationship between severe and long-continued poverty and delinquency.

Sociological research at the University of Chicago (38, 39) confirms some of the clinical findings just summarized but differs at certain points. From the sociological data, it appears that delinquency tends to be concentrated in certain geographical areas, at least in that city. In some sections, as much as 37 per cent of the whole male population between the ages of ten and sixteen may be classed as delinquent; in others, only 1 per cent of the boys within that age group have come into conflict with the law. The areas characterized by the high delinquency rates are those

with a high percentage of dependent families; thus poverty is considered of more significance than in the clinical studies. The low delinquency rates were found in neighborhoods with a large proportion of families owning their homes and obviously in better financial circumstances. The areas of high delinquency rate were also characterized by a large foreign-born or alien population, while the low delinquency areas had a small population of this type.

Like the clinical studies, the Chicago research stresses the significance of delinquent associates. An analysis of some 6000 cases of stealing showed that in 91 per cent there were two or more participants involved in the stealing episodes. The influence of older criminals upon young boys was also noted in a large number of these cases. In this connection, it may be recalled that studies of gangs and gang activities have placed similar emphasis upon the effect of companionships.

As has been implied, the recent reports upon juvenile delinquents do not indicate any extremely high incidence of mental defect or mental disease. Of the 4000 Healy and Bronner cases, only 13.5 per cent were mentally deficient, a proportion not much greater than that given by some investigators for unselected groups of school children. Burt's figure for mental deficiency for his 200 young delinquents was 8 per cent, but that for his control group was considerably smaller. Slawson (40) found 13.4 per cent of feeblemindedness in examining more than 1500 boys in New York state correctional institutions, but concluded that there was little difference with respect to mentality between delinquent boys and non-delinquents from similar economic and cultural backgrounds. On the whole, it now appears that mental deficiency is not very largely involved in contributing to delinquency. The same statement may be made with respect to other pronounced mental abnormaliites. Mental and nervous disorders, although of fairly high incidence among adult criminals, do not occur among delinquent children any more frequently than feeblemindedness.

Modern psychiatry has become interested in the motivations and mechanisms of human conduct in general and of antisocial behavior in particular. The part played by mental conflicts, especially those centering about sex, in the creation of undesirable behavior patterns was early recognized by Healy. The presence of such conflicts was reported for 6.5 per cent of the 4000 cases studied by Healy and Bronner (26), with a comment by these investigators that this figure was probably an underestimation. Burt (13) believed sex conflicts were associated with misbehavior in 8.1 per cent of his young delinquents, and thought compensatory reactions to feelings of inferiority were a factor in 10.6 per cent. Allen (3), analyzing 60 case studies from the Philadelphia Child Guidance Clinic, all referred primarily because of stealing, found that nearly half the group had acquired their undesirable behavior patterns, including the stealing, in an effort to compensate for inferiority feelings.

Aichhorn (1, 2), on the basis of his experience with juvenile delinquents

in Vienna, is of the opinion that unsolved Oedipus complexes or other psychosexual conflicts often underlie antisocial behavior. He also points out that delinquency may be an expression of rebellion against the restrictions which our social culture imposes upon direct expressions of instinctive impulses and emotions; when the child is unable to establish the self-control demanded by social standards, he may become defiant of parental and legal restraints. Pearson (35) illustrates some of the ways in which difficulties of psychosexual development may lead to delinquency. Glueck (23, 24), whose conclusions concerning delinquency are in agreement with those of Aichhorn and Pearson, further discusses the influence of the kind of identifications which the child is able to make with his parents upon personality and behavior. These childhood identifications with mother and father form the nucleus of the "ego-ideal" and "superego" for the individual, thus very largely determining the moral and ethical standards for conduct.

The psychiatric and psychoanalytic viewpoints quoted above and the comparatively few references given may be considered as samples of a large section of current thought. It is no longer supposed that child delinquency can be explained, except occasionally, in terms of extreme deviations such as mental deficiency or mental disease. The environmental situations which, according to statistical research, are frequently associated with delinquency probably gain their statistical prominence because they furnish the setting for psychosexual conflicts and difficulties in making identifications with parents. We know, of course, that broken homes, parental neglect, et cetera, do not invariably result in maladjustments for the child or in delinquency. We may therefore conclude that such situations are infinitely variable in their psychological aspects and have varied effects upon the children exposed to them. Moreover, while certain environmental conditions are likely to present unfavorable opportunities for the child's emotional growth and for the formation of acceptable personality and behavior patterns, it is also true that there are individual differences among children in their reactions to their environment. As Allen has stated (3), we can understand the juvenile delinquent only as we can see the special relation between environmental strains and the child's efforts to make adaptations to them, in each separate case.

Levy (30), evaluating the data from different sources, concludes that in some cases delinquency may be a direct reaction to environmental situations, but only when these are grossly pathological. He also believes that, in other cases, mental conflicts centering about sex or inferiority feelings are the primary factors in misconduct; the children are really neurotic, but, instead of showing the usual neurotic symptoms, they act out their neurosis in their delinquent behavior. But Levy sees the majority of juvenile delinquents as falling into a third class, their delinquency resulting from interactions between the child's individuality and the impact of the adult personalities that make up his human environment.

In thus describing three types of juvenile delinquents, Levy admits that

they are seldom to be clearly distinguished in clinical practice. There is more often, in the individual case, an overlapping of factors, but certain ones may be more prominent than others. The therapeutic procedure, Levy believes, may well be decided according to which factors or sets of factors seem to predominate in the etiology in any particular case.

Mental Diseases in Childhood

The serious mental diseases classed as psychoses are not prevalent to any great extent in the child population of the country. There is some evidence that their incidence is increasing among children as well as among adults, however. Malzberg (31) recently analyzed in considerable detail three successive United States census reports on the patients in hospitals for mental disease. He found that in most states the number of patients between the ages of ten and fourteen showed an increase in 1910 over 1904, and in 1922 over 1910; also that the rate of admission for these child patients per 100,000 of population in the same age group was increasing. Calculating the average rate of admission for the whole country, Malzberg found that it was 2.1 per 100,000 population for the ages ten to fourteen in 1904, 3.6 in 1910, and 4.3 in 1922. Lest these increases in the rate of admission seem unduly alarming, it should be noted that, of a total of 267,617 patients in hospitals for mental disease in 1922, only 634 were between the ages of ten and fourteen.

In order to obtain a sample of the trends since 1922, Malzberg studied the figures for annual admissions to the New York state hospitals from 1923 to 1930. Expressed in terms of rate per 100,000 of the state population of the same age, the admission rates for chlidren under fifteen were as follows: 3.9 in 1923, 4.6 in 1924, 6.4 in 1925, 5.0 in 1926, 5.2 in 1927, 5.3 in 1928, 3.4 in 1929, 5.6 in 1930. Except for the sudden rise in 1925 and the drop in 1929, these figures show a small but steady increase from 1923 to 1930. Again, however, the actual number of child patients is small; of the slightly over 9000 patients admitted to the hospitals in New York State in 1930, only 57 were under fifteen years of age. The admission rates for child patients are given separately for the two sexes in Malzberg's tables, as well as for both sexes. The rates for boys and girls are very close in the United States figures and also in those for the state of New York, with the exception of occasional years when there was a rather wide difference in the rates for the two sexes.

The diagnoses most frequently given for the 634 children under fifteen years of age in the hospitals of the country in 1922 were as follows: psychoses with mental deficiency, 14.6 per cent; epileptic psychoses, 11.4 per cent; undiagnosed psychoses, 8.4 per cent; dementia praecox, 6.4 per cent; manic-depressive, 5.1 per cent; psychoneuroses and neuroses, 3.1 per cent; psychoses with brain or nervous diseases, 4.0 per cent; with somatic diseases, 2.4 per cent; psychopathic personality, 2.7 per cent; and a scattering of other diagnoses under 1 per cent each—traumatic psychoses, psychoses with brain tumor, et cetera. There were 39.5 per cent of the

children diagnosed as "without psychosis." Malzberg suggests that this may mean there is a type of mental disorder among children which cannot readily be classified or that non-psychotic children are sometimes sent to hospitals for the mentally ill. We may suspect that at least a part of the group described as "without psychosis" in 1922 might now be classed under the heading of post-encephalitic mental disorder. This diagnosis is conspicuously absent from the 1922 figures quoted above, probably because the condition was not widely recognized and reported in psychiatric literature until a somewhat later date.

Some of the mental disorders of childhood have an organic or physical disease basis—for instance, those associated with syphilis, brain tumor, or other neurological conditions. There is some difference of opinion as to whether epilepsy is of organic or psychogenic origin. It is with the mental diseases generally accepted as functional—dementia praecox, manic-depressive psychoses, the neuroses, and psychoneuroses—that modern psychiatry is especially concerned. Two methods of approach to the study and treatment of these functional disorders are in vogue: The one regards them as having a psychogenic etiology, the other considers that they have a biochemical basis.

The former view is held in particular by the psychoanalytic school, which sees the functional mental disorders, as well as delinquency, as resulting from disturbances in emotional development and growing out of unresolved psychosexual conflicts. The delinquent child expresses his emotional difficulties in rebellion against environmental restrictions; the psychotic child retreats from the realities of his situation into phantasy or through regression to earlier stages of infantile psychosexual development. The psychoanalytic studies which point to a psychogenic etiology of the functional psychoses have for the most part been carried on with adult patients, but since the symptoms of dementia praecox or schizophrenia (15) and of the manic-depressive psychoses are similar in child and adult patients, the explanation should be as valid for one age as another. The neuroses and psychoneuroses will be discussed in some detail in a later section.

The most promising of the biochemical researches is probably that in which the chemist Bancroft (10) has been prominent. The theory advanced by Bancroft and his medical associates is that a variation from the normal state in the degree of dispersion of the colloids of the nerve cells of the brain may be the cause of mental disorders not directly traceable to any organic disturbances. Although such changes cannot be observed by histological methods there is experimental evidence lending support to the theory. Administration of reagents which tend to cause colloidal coagulation or dispersion produces symptoms not unlike those of the functional psychoses. Again, among patients suffering from functional mental diseases, improvement follows the administration of one type of reagent while the symptoms become more severe when the opposite type is given. For example, schizophrenics improve upon sodium amytal (a coagulating

agent) but are made worse by sodium rhodanate (a peptizing agent producing dispersion). On the other hand, manic-depressive patients improve with sodium rhodanate and grow worse with sodium amytal. Bancroft concludes that the reactions to the two drugs indicate that schizophrenia is due to dispersion of the nerve-cell colloids and that manic-depressive or cycloid psychoses are caused by coagulation of those colloids.

It remains for more extensive research to determine whether the functional psychoses are of psychogenic or biochemical nature, or whether the psychological and chemical changes are but the two sides of the picture, a result of the intimate interactions between mental and physical states. Bancroft himself, while regarding the colloidal changes as primary causes, believes that psychotherapy is advisable in conjunction with medical treatment. Theoretically, it seems possible that, even if the presence of the colloidal changes is finally demonstrated, they may follow rather than precede the psychological changes stressed by psychoanalytic investigators. In this event, the chief value of medical treatment may reside in its rendering the patient more accessible to psychotherapeutic techniques.

Neurotic and Psychoneurotic Children

Neurotic and psychoneurotic tendencies are undoubtedly more common among children than psychotic disorders. Although only 3.1 per cent of the child patients in hospitals for mental disease in 1922 were thus diagnosed, this figure offers no real indication as to the incidence. Only very severe cases of neurosis and psychoneurosis require hospitalization; for the most part they can be cared for in the home and the symptoms may not be sufficiently disturbing to parents for medical or clinical assistance to be sought. It is therefore very difficult to estimate the frequency of neurotic ailments in childhood. Moreover, the terms neurotic and psychoneurotic are used with a wider variation of meaning than that assigned to the psychoses, such as schizophrenia or manic-depressive psychoses, where there is a fairly general agreement as to the symptomatic picture.

A few illustrations from the literature will serve to illustrate the varied usage of terminology. Isaacs (27) considers that neurotic difficulties include defiance or stubbornness, failure to respond to training in cleanliness, thumb-sucking and nail-biting, difficulties with regard to food and feeding, aggressiveness, jealousy, shyness, destructiveness, stammering, sleeplessness, and inability to bear being left alone, as well as the more serious phobias or night terrors and excessive masturbation. She concludes that "neurotic difficulties of many different types, and of varying grades of severity and persistence, are fairly common among children between one and six years of age." She also states: "In the slighter and more evanescent forms, they would seem to be an ordinary feature of 'normal' development; but the severer forms requiring environmental changes or treatment are far from rare."

Chadwick (14) thinks the description *neurotic* should be limited to conditions in childhood which present similar symptoms to those of adult

neuroses, such as the anxiety and conversion hysterias, compulsions and obsessions, and neurasthenia. She also seems to class dementia praecox, which we have discussed as a functional psychosis, and delinquency under the heading of neurotic. She states that emotional frustrations, repressions, and conflicts form the roots of neurotic symptoms at all ages, but adds that the neurotic child is very often suffering from a frustration existing in the present, while the adult neurotic only remembers such frustration and dreads its recurrence.

It is generally granted that hysterical manifestations, obsessions, compulsions, phobias, and the like may be classed as neurotic or psychoneurotic symptoms. With respect to thumb-sucking, masturbation, fussiness over food, enuresis, soiling, et cetera, there is more difference of opinion. It appears that in some clinics (18) these have been regarded primarily as evidences of poor habit training, and this indeed was the viewpoint in most clinics until fairly recently. Of late there is somewhat of an inclination to consider them, under certain circumstances, as of neurotic rather than habit-training origin. This recent thinking probably would not class them as neurotic symptoms when transitory and of short duration, but would so consider them when persistent and long-continued, or when they reappear at post-infantile ages. They would be seen as natural at certain ages but as neurotic if unduly prolonged or occurring at unsuitable ages. Thus the criteria by which they would be judged as "normal" phenomena or as neurotic symptoms would approximate those already discussed in the section on criteria of adjustment.

More than twenty years ago, Freud (21) reported the case of a five-year-old boy, showing the relationship between the boy's phobia, expressed partly in an abnormal fear of horses, and his Oedipus conflicts and castration anxiety. Gardner (22) has recently published case material illustrating the rôle of castration fears in the development of night terrors. In our own clinic cases, we frequently see how fear dreams and night terrors may be utilized by the child as a rationalization for desires to sleep with the parents or to call one parent from the other and into the child's bed. We have yet to discover, through further research, where conditioned emotional responses leave off and psychosexual conflicts enter into expressions of fear and anxiety in childhood. At least, it seems that intense or prolonged fearfulness may often be considered a neurotic symptom.

Woolley (45) has emphasized the habit-training aspects in cases of enuresis and also touched somewhat upon the emotional side. Anderson (8), after studying a group of 148 enuretic patients and 50 normal controls, could not rule out habit-training factors but concluded that "emotional factors constitute by far the largest group of elements in the causation or, at least, the continuance of enuresis." In 80 per cent of his enuretics, although the average age for the group was between eight and nine years, the enuresis had persisted since infancy; in the other 20 per cent it had reappeared after a period of complete bladder control, sometimes at as late an age as twelve years. This fulfills some of our criteria for

distinguishing between ordinary habits and neurotic symptoms, since the enuresis was either of long duration or represented a return to infantile patterns.

We have reported from some of our clinic cases (4, 12) examples of the ways in which emotional deprivations (frustrations), repressions, and conflicts may underlie enuresis, soiling, excessive masturbation, continued sex play, and undue interest in obscene words. Since the etiology of these symptoms is often similar to that outlined by Chadwick (14) in her discussion of the hysterias, compulsions, and obsessions, there may be some justification for considering the former as well as the latter in the neurotic category.

However the terms neurotic and psychoneurotic may be defined, and whether their meaning be restricted or extended, it is at least possible to summarize briefly something of the modern theory concerning the nature of neurotic difficulties in children. We have already indicated that the mechanisms of frustration, repression, and conflict are involved. Klein (28) has suggested that additional factors may be found in the intensity and kinds of fixations which the child develops, and that the kind of superego formed through identifications with the parents is also very significant in the etiology of neurotic difficulties.

Delinquency versus Neurotic and Psychotic Disorders

Delinquency, neurotic difficulties, and psychotic disorders have thus far been discussed under separate headings, but this is probably a somewhat artificial division, followed chiefly as a method of organizing the material. There is some question, from the genetic viewpoint, as to whether we are justified in too wide a separation of one kind of maladjustment from another. If biochemical theories of the functional mental disorders are substantiated through further experiments, we may find that there are indeed fundamental differences between these types of maladjustment. But psychoanalytic studies indicate that the personality and behavior patterns which have led to the classification of delinquent, psychotic, and neurotic have to some extent a common origin in disturbances of emotional development. If this be so, our classifications are based largely upon symptomatology rather than etiology.

It has been stated that one characteristic of the delinquent child is a rebellious attitude toward authority and environmental restrictions; that is, he reacts aggressively toward the world. In neurotic children, fear and anxiety are often very evident. But the difference thus implied may be merely superficial. Isaacs (27) has suggested that aggression is frequently a reaction to fear and anxiety. Chadwick (14) has intimated that the rebellion of the delinquent child may be a reaction to early repressions and feelings of guilt. Pearson (35) has described cases of delinquency in which anxiety and guilt feelings related to psychosexual conflicts are the primary motivations for misconduct. Levy (30) thinks that at least some, though probably not all, delinquent children are also neurotic.

Our own clinical experience with neurotic and delinquent children bears out these statements as to the relationship between anxiety and aggression in cases which have been carried for periods of observation and treatment. Within the limits of the treatment situation, the children show intense ambivalence of emotional responses, fluctuating between love and hate, fear and anger, both in behavior and in verbalizations of their feelings. A few illustrations may be cited. A boy of six, struggling with conflicts over his attitudes toward his mother and father, in several clinic interviews displayed anxiety to the point of tears, but each time, after showing intense anxiety, turned suddenly to the opposite extreme of rage and aggression in behavior and verbalizations. As treatment enabled him to resolve his conflicts and establish identifications with his parents, both anxiety and over-aggressive reactions diminished to be replaced by increasing emotional stability.

A nine-year-old, with neurotic symptoms in the form of oral habits and tics of a seemingly compulsive type, became decidedly over-aggressive for some time after release from repressions and anxiety was brought about during the treatment. A twelve-year-old girl, in whom conversion symptoms—pains, headaches, and nausea without any physical basis—appeared after a traumatic experience, passed through a stage during treatment when momentary relief from anxiety enabled her to express some rebellion and aggression, to be followed almost immediately by recurrence of the conversion symptoms.

A boy of twelve, whose delinquencies—stealing and rebellion against authority at school and in the orphan's home where he lived—made it seem probable he would be sent to a reformatory, soon revealed the anxiety which had been concealed by his aggressive behavior. With the development of a transfer to the therapist as a parent substitute, the end of each clinic appointment became for him a repetition of his former experiences in frustration, the separation from the parent. He reacted at first to this revived anxiety over frustration with his habitual defensive pattern of aggressiveness, trying to steal something from the therapist when it was time for him to leave the clinic. When asked whether he wanted the object he was trying to steal or wished to get even with the therapist for ending the interview when he wanted to stay longer, he almost wept as he verbalized his grief over the necessity of being separated from the therapist and voluntarily restored the object he had started to purloin. In subsequent interviews he spontaneously described his feelings in situations outside the clinic, telling how he had reacted to persons who caused him unhappiness by stealing from them or trying to strike them. Obviously, his delinquent conduct was an attempt to retaliate toward anyone who aroused his anxiety over frustration or deprivation. Incidentally, the capacity which he gained in the treatment interviews to express his feelings more directly instead of reacting defensively to them soon began to carry over into his relationships with the adults at the school and at the home.

Just as it appears that in some respects delinquent and neurotic children are not so fundamentally different from one another as their surface personality and behavior patterns might indicate, so, too, we are beginning to believe that they are not so much unlike children who make more successful adjustments. The variation of the maladjusted child from the one who is reasonably well adjusted is largely a matter of degree. We have already mentioned that statistical investigations (32, 33, 44) show a continuous distribution of the same undesirable behavior patterns and "nervous" habits that occur in maladjusted children among unselected groups of school children. Isaacs (27), after twenty years' observation and study of young children, is of the opinion that nearly all children show at least minor and fleeting signs of neurotic difficulties at some time during their early development. She concludes: "The shades and degrees of neurotic difficulties grade continuously into each other, from the mildest form undeserving of any adjective but 'normal' to the severest neurosis or psychosis." Klein (28) observes that preschool children, whether "normal" or "problem," show impulses and actions in dramatic play or phantasy which, if carried over into later years and out of make-believe into reality, would be classed as criminal tendencies.

Klein also points out that the mechanisms of frustration, repression, and conflict, as well as other mechanisms, operate in the emotional development and adjustment of "normal" as well as of neurotic or delinquent children. She suggests that some of the factors which determine whether development and adjustment will be normal or abnormal are the child's capacity for bearing frustration and conflict, the intensity of the repressions, the amount of anxiety, the ability to find suitable sublimations, and the various ways in which identifications with the parents may take place. In connection with the mechanism of phantasy, Klein notes that this is used temporarily by nearly all children as a means of comforting themselves for their frustrations, but if it remains the habitual response to frustration it prepares the way for a psychosis.

Psychoanalytic literature has much to say of the part played by the superego in child development. Glueck (24) and Pearson (36) have described how the superego is formed by conditioned emotional responses to the parents and through identifications with, and imitations of, the parents; it is at once obvious that there is ample opportunity for infinitely variable superego development in different individuals. There seems to be a fairly general agreement that the neurotic has a very severe and strict superego which imposes continual frustration, repression, anxiety, and feelings of guilt. Aichhorn's (2) suggestion that delinquency may be due to lack of control over impulses would perhaps imply a lax superego or incomplete superego formation as one differentiation between delinquency and normality or neuroticism. Klein (28), however, thinks delinquent tendencies are not due to less strictness of the superego but rather to a superego working in a different direction from that of the normal or neurotic person. We may perhaps summarize the psychoanalytic contri-

butions by emphasizing that there are wide individual differences, not only in superego formation, but also in the operation of such mechanisms as repression, sublimation, retreat into phantasy, et cetera. Probably not any one of these, but all of them in combination and interaction, have much to do with normality or abnormality and with the form of the latter.

Perhaps we may assume that inherited or congenital differences among individual children permit some to bear frustration and conflicts or to find sublimations better than others. Still, we cannot disregard the influence of environmental circumstances, especially those existing within the parent-child relationships, as Glueck (24), Klein (28), Levy (30), Pearson (34, 35), and the other contributors whom we have been quoting all agree. Upon these parent-child relationships, to considerable extent, depend the varying degrees and amounts of frustration which may be imposed on the child as well as the kinds of gratification which may be provided in excess and thus lead to fixations at infantile levels. In the parent-child situations, too, are frequently acute traumatic experiences or more chronic pathological conditions affecting early psychosexual development. Again, parental attitudes may reinforce repression or favor sublimation, and may foster or impede normal identifications with the parents and wholesome superego formation. The psychological aspects of the parent-child situation, more than any other single group of factors, are important for adjustment or maladjustment and for the direction of the latter toward neuroticism, psychotic states, or delinquency.

Educational Disabilities and Speech Difficulties

In the ten years since the beginning of child guidance clinics, we have become interested in many kinds of maladjustments besides those which may be classified under the headings of delinquent, psychotic, or neurotic. Two types of difficulties for which childern are often referred to clinics have previously received considerable attention from psychologists—special educational disabilities and difficulties in speech development. The psychological research is familiar and is touched upon in other chapters, so that it need not be summarized here. We may simply mention that it has been the starting-point for our clinical approach to these problems.

Our clinical applications of psychological testing techniques and remedial methods have been supplemented by our interest in emotional growth and development. Sometime ago we reported from the Philadelphia Child Guidance Clinic some of our early cases of reading and arithmetic disabilities (11) in which there was evidence that emotional responses and attitudes associated with those subjects were factors contributing to the disability. We are now preparing for publication a series of reports (37) based upon more intensive and extensive study of 73 cases of reading disability. In so far as this project has been completed, there are certain interesting findings upon which we may give preliminary notes, leaving a more detailed presentation of our data for the final publications.

The results of diagnostic tests in our cases of reading disability indicate that the points at which the reading process most often is inadquate are those described by Gates. Poor visual discrimination for words characterizes more than 30 per cent of our children with reading disabilities, and is combined with poor auditory discrimination for phonetics in another 24 per cent. On the other hand, the difficulties in reading described by Orton and Monroe, such as reversals of letters or sequence, change in handedness, and confusion of orientation, are present in a much smaller proportion of our cases. Reversals, for instance, are found in approximately 14 per cent, but in all but two cases other difficulties of the kind emphasized in the work of Gates are also prominent.

Emotional reactions of anxiety and inadequacy to the reading tests were displayed in marked degree by ten of the children in our clinical group of reading disabilities. Intellectual handicaps were not a factor in the poor reading; only 12 per cent of the children were below IQ 90, none were below IQ 70, and some 31 per cent were between IQ 110 and 140.

The whole clinical picture in many of our cases leads us to believe that other emotional factors are involved in the production of the reading disability besides the attitudes toward reading. We find, as did Gates in his studies, that for the most part the trouble with reading had its inception while the children were in the primary grades, where the pupils are supposed to acquire certain fundamental mechanics of reading. The histories of some of our older cases and observations of the younger ones suggest that emotional disturbances arising from traumatic experiences outside the classroom may interfere with the efficient functioning of the complex learning process involved in the acquisition of the fundamental reading skills. There are further suggestions that children entering the primary grades while still struggling with unsolved psychosexual conflicts and yet in the process of trying to make identifications with their parents are also likely to have trouble in learning to read.

Too great emotional conflicts apparently prevent the child from being able to put forth the effort and sustained attention necessary for learning to read. In some of our first- and second-grade cases, treatment has been directed toward enabling the child to solve these emotional conflicts rather than toward remedial teaching. When this therapeutic aim has been accomplished, the child may learn to read in school without supplementary remedial teaching being required or this may become the next step in treatment. In certain instances, we have found children unable to benefit from remedial teaching until their emotional difficulties have been ameliorated. On the other hand, for children who are free from immediate and severe conflicts, the remedial teaching alone is extremely effective in correcting the reading disability.

In turning to the subject of speech difficulties, it seems needless to review the literature on speech training or that which regards speech defects as symptomatic of nervous or emotional instability. Nor need we go into detail concerning the relationship between certain physical defects and mal-

formations and faulty speech. The data and theories from these different approaches to the problem are too well known to be recapitulated here. The clinical viewpoint takes all possibilities into account in the diagnosis of any given case and bases recommendations for treatment upon whatever group of factors seems to predominate over others. Medical attention would thus be indicated if physical malformations are involved in the speech difficulty; in other cases speech training might seem the best procedure, while in still others therapy might be directed toward helping the child achieve better emotional adjustment.

We should like, however, to comment briefly upon a type of speech difficulty which has not received any wide consideration heretofore. In the Philadelphia clinic, we have recently come into contact with a number of cases which do not seem to fit into the usual classifications of speech defects. We have seen a small group of preschool children whose language development was described as normal up to the age of eighteen months or two years, when it was suddenly interrupted. Most of the children have been between three and four years of age when referred to the clinic; some had entirely stopped speaking, although they had used a few words a year or so previously, others still used those words but had not enlarged their vocabularies.

Clearly, these interruptions of language development do not resemble the delay in beginning to talk and the slowness in acquiring correct pronunciations and learning new words typical of the retarded speech development of the mentally deficient child. Moreover, in our cases, the responses to intelligence tests were adequate on the non-language requirements and also in understanding and carrying out instructions which did not demand a verbal response. Thus, in spite of being penalized by failures on parts of the tests requiring verbal responses, the intelligence test ratings for this group of preschool speech cases ranged from IQ 80 to IQ 125.

In this special group of speech cases, there were evidences, even in the testing situation, of emotional immaturity and negativistic attitudes. It was often difficult to secure cooperation; their initial reaction to instructions during the testing was refusal to carry out instructions. Considerable skill and patience was necessary to gain anything except this negative type of response. Observations of play showed infantile behavior patterns which would ordinarily be expected in a child under rather than over two years of age. When blocks, toy trains, dolls, et cetera, were provided, there was a marked tendency on the part of these children to point to a desired plaything and wait for it to be picked up and handed to them. If a toy was given to them, it was pushed aimlessly about, dropped on the floor, or carried to the mouth. This infantile behavior seemed to us to indicate that the arrest or retrogression in language development was but part of a more general picture of arrest or regession in emotional growth.

The histories furnished by the parents were also suggestive in connection with the possibility of a blocking of emotional development. In part

of the cases, the child had been nursed or bottle-fed to a comparatively late age, and otherwise given a solicitous care which offered little opportunity for the exertion of effort to satisfy wants. In other instances, habit training and play activities had been closely supervised and the child had been subjected to an exceedingly repressive kind of discipline. These parental attitudes may have become obstacles to emotional growth which the child was unable to overcome, causing an arrest in development or, in some cases, a turning-back to infantile ways of gaining emotional satisfactions, with self-assertion possible only in negative ways.

Our treatment was directed toward providing an opportunity for freedom in play activities and stimulating initiative and effort. When wants were indicated by means of gestures, the therapist did not gratify the desire so expressed but merely showed an understanding of it by such a remark as: "You would like to play with the doll, wouldn't you? You may get it and play with it, if you like." In a short time, the child's desire for the plaything would motivate efforts to gain satisfaction. Soon the use of gestures, since these did not succeed in bringing gratification of desires, was relinquished, and the child began to take the initiative in getting the wanted toys without waiting for the therapist to suggest his doing so. Later, the play changed from the first infantile putting things in the mouth or dropping them on the floor to a more mature interest in building with the blocks, drawing with the crayons, et cetera.

As the children found pleasure and satisfaction in the play and in self-expression, and as a stronger transfer to the therapist developed, dramatizations of their feelings and impulses began to color the play activities. At the same time came the wish to talk about what they were doing and to communicate with the therapist. In some cases, the early stages of speech development were repeated rapidly in the treatment interviews, progressing from infantile cooing and babbling to inflected sounds resembling words and finally to the use of words and sentences plainly enunicated. Certain of the children at once began to talk in words and sentences. The whole course of the changes shown by the children in successive treatment interviews was one of growing out of infantile emotional patterns and behavior into those suitable for their age, and a turning from negative to positive modes of expression. The resumption of talking seemed to be an accompaniment of the emotional growth and the increasing ability to find satisfaction in positive rather than negative, or active rather than passive, ways. It is interesting that these responses to treatment took place within short periods of time, usually within two or three months during which the treatment interviews took place only one or two hours weekly. Also, the changes occurring during the clinic interviews were carried over into the home environment.

Studies of the Only Child

There have been suggestions, in connection with the study of adjustment difficulties of children, that the size of the family and the child's

position in it may have some etiological implications. Particularly has the only child been singled out, in some of the literature, as peculiarly liable to difficulties. Statistical research does not seem to bear out this opinion.

Ward (43) compared 100 only children referred to several child guidance clinics with a control group of the clinic cases from three-child families. She found no marked differences in the kinds of maladjustment shown by the only children and the controls, except that there seemed to be less lying, stealing, and truancy among the only children and more difficulties of the sort which we have classed as neurotic symptoms. Goodenough and Leahy (25) compared 41 only children referred during a certain length of time to the Minneapolis Child Guidance Clinic with the other clinic cases for the same period, finding more neurotic tendencies for the only children. In a similar comparison of 46 only children in kindergarten with other kindergarten pupils, these two collaborators described the only children as more self-confident and aggressive, rather than more neurotic, although less stable in mood. Fenton (17) reported that in groups of public-school children and college students the only children showed fewer nervous symptoms than the others.

It appears, then, that the only child does not stand out from the general run of unselected school children by reason of more frequent difficulties of adjustment, for the studies made thus far show no higher incidence of maladjustments among only children than among those with brothers and sisters. But it is suggested by the clinical reports that difficulties occurring among only children are somewhat more likely to take the form of neurotic rather than delinquent tendencies.

Treatment of Children

The history of clinical work with children during the last ten years might well be written in terms of the experimental search for effective treatment techniques. Allen has reviewed some of these experiments (5) and has also pointed out the necessity of flexibility of approach in treatment (6). Social case work with parents has been and continues to be an important part of the clinical program, with its methods being constantly modified and improved. There is a growing belief in some clinics, however, that, in addition to case work with parents, direct treatment of the child is also necessary in many instances.

Our current experiments in therapeutic techniques have borrowed certain elements from child analysis but with modifications. Klein's (29) chief contribution to child analysis has perhaps been her development of the play technique. In the treatment of young children in the clinic, the free play situation is extremely valuable. Not only are the child's emotional conflicts portrayed very vividly through dramatic and make-believe play, but emotional development also seems to take place.

In child analysis, Klein considers that the rôle of the therapist extends beyond the setting-up of the free play situation; in her recent book (29)

she repeatedly stresses the importance of interpretation of the child's play activities. Clark (16) also sees interpretation of the play as an important therapeutic factor. It is at this point that our clinic procedure tends to depart somewhat from that of child analysis. In some of our experiments with play technique, there has been no interpretation, in Klein's sense, by the therapist. What interpretations were made were by the child himself, either in spontaneous comments upon his activities or in reply to questions from the therapist. Yet in our cases in which the therapist did not assume the rôle of interpreter, there have been, so far as one can judge, the same expressions of psychosexual conflicts and the same indications of emotional growth in the changes of play activities during the course of treatment and in better adjustment of the child outside the clinic, as in the cases reported by Klein (29) where interpretation was more actively undertaken.

Hence, in the treatment of preschool children, it seems possible that some of the results frequently ascribed to the use of interpretation may be otherwise derived. In contrast to the insistence upon interpretation, there may be advanced the concept of growth in child psychology. Gesell sees the growth impulse as existing from infancy and as a function of life; there is always the tendency within the individual to strive toward the optimal potentiality for physical and mental development. In all probability, the same growth impulse also furnishes an impetus to optimal emotional development and a striving toward harmonious adjustment. If this be true, once we have provided a situation which leaves the child comparatively free to follow his natural impulses, we may logically expect emotional growth to take place and new modes of adjustment to be evolved, without excessive activity in the form of interpretation on the part of the therapist. The validity of the growth concept seems to be further indicated by the fact that the child carries over into his daily life the more mature emotional responses and the improved ways of making adjustments which are first achieved in the clinic treatment interviews.

This approach to the treatment of the young child is far removed from the once prevalent theory that the chief aim of treatment was working with the parents in order to modify the child's environment or to supervise habit training. While it may be desirable to provide a more favorable environment, it is a part of our current thought to recognize also the child's need for an opportunity to strengthen himself against external pressures and to learn to bear frustration and conflict without succumbing to them. No human being can hope to go through all of life without meeting frustration or undergoing conflict; the whole trend of modern psychology indicates that the ability to adapt to such experiences depends very largely upon the patterns of response to unpleasant situations set up in early childhood.

In stressing the freedom of the child in clinic treatment with the play technique, it is not intended to imply that the therapist never asserts any control of the situation. By freedom we mean that it is left to the child

to initiate play activities with the materials and toys from which a choice may be made; the therapist does not suggest what shall be selected or how it shall be used, but observes the play or participates in it when requested to do so. But the therapist actively controls the time element in the treatment interviews by not permitting them to be prolonged beyond the allotted hour and also sets a limit upon the child's activities at certain points. In the course of treatment, the child's transfer to the therapist may increase to a degree where the loves, antagonisms, and resentments which have grown up in relation to the parents and as reactions to their care and training are projected onto the therapist. In the treatment interviews, the child is permitted to express sex and love impulses or hostility and resentment fully and freely through play, phantasy, or verbalizations. As the transfer becomes more intense, the young child frequently is not content with these indirect expressions but attempts a more direct expression of impulses with the therapist as the object. Such attempts at direct expression are checked and prevented and the child is turned toward other ways of expression through play activities or verbalizations of his feelings.

There are therapeutic reasons for this kind of control in the treatment situation. If direct expressions toward the therapist are permitted, the treatment relationship becomes too personal and the child may find in it gratifications which block his dramatizations and verbalizations of his emotional conflicts and prevent further emotional growth. Again, while the child is required to forego direct expressions of sex desires, anger, and resentment, at the same time they are recognized as natural impulses and free expression of them is allowed in indirect and more or less sublimated form. Thus, not only is the child prevented from building up too personal and emotional a relationship with the therapist but also he is helped in beginning to control and redirect his impulses and perhaps to use the mechanisms of repression and sublimation in healthy ways. It may be, too, that there is some analogy between this kind of control from the therapist in clinic treatment and one of the functions of the child analyst described by Anna Freud (19), who suggests that one of the analytic tasks is to reinforce the child's immature superego and help him in gaining self-control.

The timid, submissive child needs less restrictions imposed by the therapist and must rather be encouraged to free expression of his impulses. Perhaps we might say that here the therapeutic activity is directed toward strengthening the ego rather than the superego, if we wish to use psychoanalytic terminology. The submissive child is hesitant, in early treatment interviews, to take any initiative in deciding upon play activities and has to be informed repeatedly that he may do whatever he wishes. Characteristically, in such cases, the play remains for some time of a conventional nature which reveals little of the child's real feelings or emotional conflicts. Gradually highly symbolic expressions of impulses and conflicts appear in the play activities, to be followed by more open expressions and

dramatizations of feelings and desires. Sometimes, as the transfer to the therapist develops, the child is carried from submission to the opposite pole of aggression; if so, the therapist's activity again becomes one of limitation and control until the child learns to manage his impulses and feelings through sublimation.

In the treatment of children, the therapist must be alert to his own reactions as well as to the meaning of the child's activities and attitudes. The background and interests of the therapist, or his own unsolved personal problems, may lead to conscious or unconscious effort toward too much direction of the trend of the child's play and verbalizations. The essential therapeutic attitude is an open-minded approach and a willingness to use whatever techniques seem best adapted to the individual child.

Treatment of older children probably varies somewhat in different clinics and with individual therapists in the same clinical organization, as does the treatment of young children. Even in the field of child analysis, illustrations of divergent viewpoints and techniques may be seen if we contrast the applications of Freudian methods evolved by Melanie Klein (29) and Anna Freud (19), and again if we contrast the work of these two representatives of the Freudian school with Jessie Taft's use of Rankian techniques (42).

The therapist who adheres strictly to the Freudian viewpoint may feel that the chief aim in treatment interviews is to have the child reproduce memories of sexual experiences, phantasies, and conflicts, with interpretations of this material to be made by the therapist. While such a specific aim may be suitable for child analysis, it may be questioned whether it is equally desirable in clinic treatment. Many children are resistive toward attempts to induce them to relive their past experiences and feelings but are worried about immediate adjustment problems and have a real desire for help on this basis. Resistance toward reproducing past conflicts and toward accepting Freudian interpretations may be somewhat different in the child than in the adult. It is possible that during the latency period the child's resistance to the revival of earlier psychosexual conflicts is an effort to protect himself from too great emotional strain during this period of emotional development. While the child analyst may be justified in breaking down such resistance, it is possible that it should be respected as a healthy impulse in the clinic treatment situation, where the therapist is likely to have less frequent contacts with the child and often for a shorter length of time than is usual in child analysis.

It may be of more therapeutic value, in some clinic cases where such resistance is encountered, to accept the child in his own terms of the present without trying to press too far back into the past. The therapeutic aim would then be limited to helping the child go as far as he is able, with interpretation chiefly in terms of the child's reactions to the therapist in the transfer to the latter, recognizing both the positive and negative elements, and of activities occurring in the treatment interviews

or material spontaneously produced by the child. The therapist certainly needs to be constantly aware of the deeper conflicts and the mechanisms of repression, defense, projection, retreat into phantasy, et cetera, from which immediate activities and reactions spring. But it is not necessary for the child to be as conscious of these mechanisms as is the therapist, for comprehension of the undercurrents to his responses and behavior is of less therapeutic value to the child than the emotional experiences within the treatment situation and the emotional growth which may thereby be made possible.

In even a brief discussion of treatment, we must not neglect to say something about the relationship between the child and the therapist and its meaning for human relationships as a whole. The contact with the therapist offers an opportunity for a new adventure in human relationships, which will not be colored by authority or by demands upon the child for any particular emotional responses except those prompted by his own nature and need for expression.

Just as the young child is free, in the play situation, to choose his activities and to carry out his impulses and wishes within certain therapeutic limits, so the older child is free to make what use he desires of the relationship with the therapist. If there are restrictions placed upon certain ways of expression with older as with younger children, yet in both instances these restrictions are maintained without any accompaniment of disapproval for the feelings which have prompted the behavior and with recognition and understanding of those feelings on the part of the therapist. Thus the important factor in clinic treatment becomes the child's capacity to make use of the relationship with the therapist to project into it what emotions he will, to express both positive and negative feelings, both love and hostility, and through it to find some balance between impulses to submission and aggression.

The neutrality of the therapist, who does not meet love with love, or hostility and aggression with similar attitudes, but with the understanding that all are natural human feelings, provides a stable situation in which the child may express himself freely and evolve some integration of the ambivalent impulses within himself. Obviously, neither parents nor teachers are in a position to assume the withholding of emotional response united with the giving of understanding, for in the child's mind they cannot be divorced from the rôle of dispensers of approval or disapproval, authority, and affection. These are responses the child expects and wants from the adults with whom he is associated in daily life. But the neutrality of the therapist can be accepted and out of this particular experience in human relationships the child may be able to bring into other contacts at home and at school an ability to make adjustments on the basis of reality rather than by an expression of unintegrated impulses of love or hostility, submission, or aggression. How far the child can progress in the treatment relationship and how much he can gain from it will depend

upon his own innate capacity for growth as well as upon the skill of the therapist.

Although we have been discussing the matters of interpretation and relationship separately, they are actually inseparable in treatment. The relationship factor is always present, and, if the child continues in the treatment situation for any length of time, it is almost inevitable that his activities or the material produced verbally will be such that some sort of interpretation may be utilized. In a sense, the kind of activities and material produced are a measure of the child's capacity to make use of the relationship and to find in it an opportunity for emotional growth.

In this brief discussion of treatment, we have merely outlined some of the general principles and significant elements. We may well emphasize once more that the important factors are the therapist's limitation of his own activity to therapeutic ends and his adaptations of techniques to the individual child, together with the child's own capacity for growth. The maintenance of a neutral attitude on the part of the therapist prevents the treatment relationship from growing into something more personal and less easily terminated when its service has been rendered. Because of its impersonality, although there may have been warmth and understanding in it, its ending need not be too painful for the child.

In the child's capacity for growth lies his ability to bear the termination of the treatment relationship and also to carry over into other situations what has been gained from it. He is consoled for his separation from a person who has given him an experience in freedom and understanding by the satisfaction which has come through his emotional growth and better adjustment and by the still further satisfaction which follows the achievement of independence of the therapist. It is entirely natural for the child to find satisfaction in release from dependency upon others and to separate from those whom he has used in his emotional growth. The whole pattern of normal childhood development is one of gradual increase of self-dependence and separation from the parents, until at last the individual is free to fulfill his own destiny and to establish new relationships in love and marriage. If there is an impulse toward separation from the parents, upon whom there was once almost complete dependence, it is not surprising that there is also a drive to separate from the therapist when the latter has served his purpose in contributing to the child's development. The final task in treatment is for the therapist to recognize the signs of the child's readiness for the termination of the therapeutic relationship and help him to bring about this ending.

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CHAPTER 23

THE ADOLESCENT CHILD

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INTRODUCTORY REMARKS

In the present attempt to present the topic of adolescence, the aim will be to outline in synthetic fashion the existing research and to organize the facts around the life-problems which are basic to this period of immaturity. No effort will be made here to append an exhaustive bibliography. On the contrary, reference will be given to recent texts which present bibliographies (6, 39, 75), and to researches which are so recent that they post-date existing texts and bibliographies, or which for other reasons have not been included in them. Works which are of historic importance, but which are founded on points of view, methods of inquiry or supposed facts, which are now largely obsolete, such as the volumes by Hall (29), are cited to give perspective in the field.

There has been during the past decade a renaissance of scientific interest among psychologists in the study of adolescence. This is conspicuous in Germany, in the United States, in Russia, and in Great Britain. This activity may possibly be related to social phenomena represented by "youth movements" since the War. In any case, the psychological literature dealing with adolescence has been notably augmented during the recent past.

DEFINITION OF ADOLESCENCE

Adolescence is usually defined in terms of time, as being the years of the teens, falling between the twelfth and the twentieth birthdays. Sometimes, however, we find "adolescence" taken to mean the period which begins with puberty, when the first signs of reproductive power appear, and which ends with the cessation of growth. So considered, in terms of biology, adolescence still falls characteristically into the teens for members of the human species wherever found. This period, roughly of seven years, covers the somewhat ambiguous phase of development when the person is no longer a child, yet has not reached the condition of full maturity. The German word, *Reifezeit,* expresses the situation better, perhaps, than any other.

Individual differences in rate of development are, of course, very wide. Puberty, as determined by age of first menstruation among girls, may occur anywhere from nine to eighteen years of age in a random sample no larger than ten thousand cases, limited to the same race (39). There is evidence that conditions of nutrition affect somewhat the advent

of puberty (70). Puberty among boys is more difficult to study than among girls, because the criteria are not so well agreed upon. Criteria, such as growth of pubic hair, show wide variations in relation to age.

In all phases of growth, diversity is so great that no statement we could make would hold for all persons at a given age. The observations here offered will be understood to pertain to the *typical* adolescent unless otherwise stated.

Problems of Transition

During the approximately seven years of adolescence, the human being must normally pass quite completely from one set of habits to another, and from one set of values to another. He has to break habits of obedience and dependence, which are proper to an immature child, and must, on the other hand, build up habits of self-determination and of self-support, which are suitable to an adult. This is, therefore, a period which is hardly equaled for perplexity and uncertainty of status, save for accident, by any other developmental phase of life.

It has sometimes been dogmatically stated that a condition of emotional upheaval is inevitable in adolescence, because of the introduction of new glandular elements into the organic economy. No proof has ever established this as a fact. Emotional outbursts are common to those who feel uncertain of their status, quite regardless of the age of glands.

The disturbances connected with uncertainty and orientation have been studied by means of the psychogalvanometer. Wechsler (94) has observed that it is in the period of orientation toward a situation, while the person is trying to get his bearings, that the most marked deflections are recorded. When the stimulus experimentally applied has once been fully met, the subject "settles down," and no longer registers the abnormal disturbance. When the situation becomes very familiar, the excitement may disappear entirely, so that no deflection whatever is recorded.

There is a sound parallel between these situations of the laboratory and the life-situations in which adolescents are involved. Silly and annoying behavior in the teens is often the result of incomplete orientation on the part of the adolescent, who is disestablished in regard to old habits, while not yet sure of himself in regard to new ones. Mead (55), in observing adolescent behavior among the Samoans, offers the conclusion that adolescent instability is simply an instability of social-economic status, due to civilization with its artificial requirements, and not indigenous to the organism itself.

Indeed, it would seem obvious to common sense, unassisted by scientific observation, that the civilized adolescent is necessarily in conflict with the conditions of life which make it impossible to mate, to earn a living, and to exercise self-determination at the biologically appropriate time. The biologically appropriate time, when the organism is "ready" (82), is no longer the socially appropriate time, because of the continuously rising "standard of living" (62), which comes with high degrees of civilization.

The major interests and conflicts of adolescence center in needs which are not urgently present until the teens. They arise as size and strength increase, as intelligence grows, and as the person becomes capable of reproduction. These basic needs, around which the psychology of the period is organized, are (1) for freedom from the supervision of the family, (2) for association and acquaintanceships with members of the opposite sex, (3) for self-support, and (4) for a point of view upon the world that will unify life and give it meaning (39). "Finding the self" consists in meeting all of these needs, and organizing them into a harmonious set of habits. A systematic account of adolescence calls for consideration of these universal, persistent problems, one by one.

Psychological Weaning

The need which is basic to all successful maturing is that of winning emotional detachment from the home of childhood. Every normally constituted adolescent feels the impulse to become separate from his parents, no matter how much he may love them, and to decide things for himself. Studies of disagreement between adolescents and their parents (50, 51) show that discord arises largely through attempts to secure freedom from familial supervision in regard to bedtime, fashions in dress, use of conveyances, choice of friends, and other matters of social activity. Rebellious behavior occurs to some extent in nearly all cases, according to the reports of adolescents themselves. Separateness in matters of conscience and of religious thought is also likely to be sought (49). Adolescents' problems are much concerned with the technique of detachment from parental authority.

The practical questions are such as these: How old should a boy or girl be in order to make his own social engagements, to have a latchkey, to choose friends independently, to select clothes without supervision? Certain rather similar questions are in our times settled arbitrarily, by impersonal law, as, for instance, the age for paying full fare in public carriers, for achieving a license to drive an automobile, for receiving working papers, and for marrying. All questions of personal autonomy are in the early history of races decided by public action, irrespective of parental appraisals (30). The primitive boy or girl is tested, in public, by tribal representatives, to determine fitness for participation in adult life. If the novice "passes," he is formally declared adult, and is thereafter subject to tribal as distinguished from familial authority. Under primitive conditions, this occurs at or before the middle teens (30).

Emancipation from the family is now left among modern civilized peoples to private discretion. Since voluntary habit-revision in any phase of conduct is always difficult, the result of this policy is that many persons pass through adolescent years without being rid of their cradle-habits, or, as Watson call them, "nest-habits" (93). Others are permanently distorted in their attitudes by the struggles which they wage against the blind forces of parental possessiveness (39).

In everyday life many people may be noticed, who are long past adolescence, still obedient to and dependent upon parents or parent-substitutes. A woman of twenty-six refused to go on her honeymoon unless her mother could accompany her, which was done. A man in his thirties, caught in the United States military draft, was so upset as to be unfit for military duty. His mother laid siege to the offices of the military authorities to have her son released on the ground that he was her "baby," had never slept away from home in his life, and could not live away from his mother (93).

Such cases as those described above suffer from an emotional disorder commonly called *homesickness*. This condition has not yet been systematically studied as to origin and manifestations. It is a reasonable hypothesis to suppose that failure to revise habits progressively as age advances is its basis. The theory that the attachment to the parents is sexual in nature (21) is superfluous, for the same kind of behavior may be witnessed in cats, dogs, or horses, which have been removed from their keepers who have habitually supplied them with creature comforts, more especially with food (59).

Homesickness interferes with all the processes of growing up—with mating, with occupation, and with point of view on life. The hypothesis offered is that it may be prevented by continuous habit-revision, as the child grows, in the direction of increasing emotional independence (39). This is much more difficult to bring about with some children than with others. In experimental talks with elementary-school children on the subject, "Growing Up," several pupils expressed the idea that it would be desirable to remain in babyhood (78). For instance, one sixth-grader said frankly, "I want to be a baby. You get more service." Some feared that by growing up they might lose the love of their parents.

The Development of Sex Interest and Sex Behavior

It is clear both from common observation and from statistical study (32, 77) that adolescence is the period when impulses to mate come to their full development. Data collected by Hamilton show that the peak for frequency of love affairs is reached, in persons of good intelligence, in the years between thirteen and twenty-one. This general statement holds for both sexes, though girls rise to their peak of frequency more sharply and a little earlier, as shown in Figure 1.

Due to the tabu on conversation about sex and on sex instruction, which has developed since the days of savagery, we find very little scientific work done to establish facts about the psychology of sex in human beings. The origins of this tabu are in dispute, but probably it is largely to be accounted for on the basis of economics (18, 39). As it became impossible for the pubescent to support himself, to say nothing of offspring, in a complicated society, it became desirable and even necessary for the elder members of the community to restrain him from following the normal course of sexual desire. The easiest method of setting up inner obstacles in the

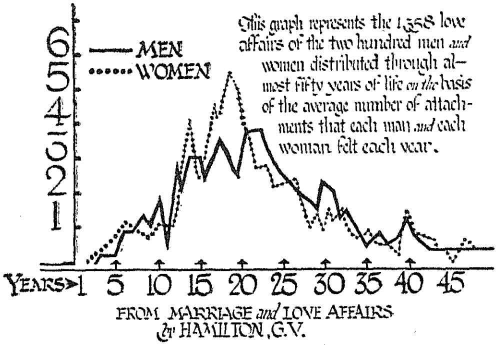

FIGURE 1

SHOWING THE FREQUENCY OF LOVE AFFAIRS, AS RECALLED BY ONE HUNDRED MEN AND ONE HUNDRED WOMEN OF THE PROFESSIONAL AND BUSINESS CLASSES WHEN MOST OF THEM WERE BETWEEN THIRTY AND FORTY YEARS OF AGE

The frequency is related to age, indicating the average number of affairs per person, remembered as having occurred at each age. Note the peak at adolescence in the case of each sex.

(From G. V. Hamilton and K. Macgowan's "Marriage and Love Affairs." *Harper's Mag.*, 1928, **157**, 277-287.)

young is to shame and frighten. Tabu provides a method of control that is easy for the elders to employ.

This method of tabu has taken somewhat different forms as applied to the two sexes. In the case of boys, the attempt has often been to shame their natural desires by presenting them with the idea that women are sacred, and too fair and fine to be regarded with any but the most worshipful thoughts. It is suggested to the boy that in considering women he should always have his mother and sister in mind, and should speak, act, and think in terms of mother and sister in his approach to women. These are, however, very unrealistic habits of thought, and if taken seriously may do great harm to the adolescent boy. Cut off from the natural attitude toward "good" girls, he cannot but discover sooner or later that not all girls are "good," and that there are many women whose business is to solicit from him the very behavior which he has been led to consider "bad." A schism is likely to be thus set up in the boy's emotional life between "good" women and "bad" women which will render it possible to approach none but the latter in a natural manner, since the former have been identified with mother and sister (38, 41, 82). Happy and suitable mating may thus be made difficult or impossible in later life.

In the case of the girl, the attempt has typically been made to frighten her from intimate contact with members of the opposite sex by implying that men are dangerous, mysteriously charged with ruin, and filled with sinister intention. The tabu thus set up is effective in proportion to the intelligence and sensitivity of the girl, and "protects" many not only until marriageable age, but for a life-time, from all possibility of normal and spontaneous sex expression (38, 41, 82).

Most of the verifiable scientific evidence available in regard to the normal psychology of sex has been collected from the study of infrahuman animals. We shall have occasion to cite these, in default of data on humans. Such matters as these are in question: How does love develop? How does love come to attach itself to members of the opposite sex, and at what age does this begin to occur? What are the normal stimuli to sex attraction, and why are not all members of the opposite sex equally attractive? How do individuals differ in respect to sex needs? How does sex compare in strength with other primary animal drives? Do males and females respond in the same way to sex objects? What are the characteristic acts of courtship? How does sex desire vary with age? With what concomitant conditions does sex attraction wax and wane? What happens when sex desire is thwarted, as by absence of biologically appropriate sex objects, or by inner obstacles of tabu? How do unusual or perverted modes of sex expression develop? Does sex in human beings tend naturally to monogamous mating? To most of these questions we have very fragmentary answers, or no answers at all, save those of general wisdom.

It is now no longer assumed that the little child is sexless in all his interests, nor that sex develops suddenly at adolescence. Sexual reflexes are present from birth, and sex play is a phase of child psychology. It is, however, thought at present that previous to the onset of puberty the child is not definitely heterosexual. Its longings for human contacts have been vague and unlocalized, its affections attachable somewhat equally to persons of either sex. With the development of the sexual apparatus, and the beginning of reproductive power, there comes normally an inclination toward members of the opposite sex in preference to members of the same sex, which has come to be called *heterosexuality*. Hughes (42) found that among 1029 adolescent boys replying to a questionnaire, the average age of beginning of sex consciousness was reported to be twelve and one-half years.

Apparently, it is during adolescence that the emotional attitude of heterosexuality becomes normally established. The four or five years following puberty are the best years for this development. Furthermore, normal development requires normal stimuli, in this case members of the opposite sex, of appropriate age, and in other respects attractive to youth (39).

This brings us to the question as to who are attractive to adolescents, as sex objects. Normally, as stated, the most potent stimuli to sex activity are persons of the opposite sex. Not all persons in this category are equally stimulating, however. From questionnaire studies of this matter it would appear that physical beauty, especially of the face, is the most potent stimulus. Some testify that the face has relatively little potency for them, beauty of body, or of some parts of the body, such as hands or feet, being more important. Occasionally, very minute details are mentioned as of greatest power to attract, such as the teeth, the lips,

or the ankles. Manner of dressing is more alluring in certain cases than is the person dressed. As for special causes of repugnance, adolescents mention "resemblance to animals," deformities, and deviations in size (39). According to the data collected by Hamilton (32), adolescents of both sexes are in the great majority of cases attracted to persons of the same age as themselves, in the course of their love affairs. A small but considerable percentage of adolescent love affairs are with older men or women. Almost no love affairs of boys and girls in the teens are with persons recognized as younger than themselves. This would indicate that *age* is an important factor in sex attraction, the adolescent being attractive to the adolescent.

Although physical appearance, including dress, is evidently the single most important factor in sex attraction for the young, it is nevertheless true that adolescents of the quality found in high school report other qualities as having effect. In describing the "ideal boy" and the "ideal girl," such factors as intelligence, personality, honesty, affection, good manners, health, morality, and ambition receive conspicuous mention.

There is, of course, much disagreement from person to person, and from race to race as to what constitutes physical beauty (53). "Styles" in beauty come and go. Dress is especially subject to this fluctuation of standard, ordinarily called "fashion," and clothes are more important in the emotional life of the individual at adolescence than at any other period. Hurlock (43) has found that when mature people are questioned, "adolescence for two-thirds of the group, and maturity for one-third, seem to be the times when social approval of one's clothing is most strong and influential in the individual's life. Two-thirds of the group claimed that adolescence was the period of life in which happiness, efficiency and behavior were most affected by clothes. . . . . The same percentage claimed that their self-confidence was increased by being well dressed in adolescence." Macaulay (52), from questioning children and adolescents from six to fifteen years of age, concluded that up to the age of nine children look upon clothing simply as being decorative, laying stress upon brilliant color only, in choosing. Up to age nine, "clothing has little if any significance for the self, and is not considered when the claims of the body for physical enjoyment are to the fore." From the tenth year to the twelfth, attention to design and cut begins to appear, and the edicts of fashion begin "to oppress the child," so that physical comfort will be sacrificed to some extent in consideration of clothes. During adolescence willingness to sacrifice bodily comfort for the sake of fashion in dress is developed. From such studies as these it is evident that clothes play a very important part in the psychology of adolescence, since upon them may depend to a large degree failure or success in the sphere of sex attraction. Stealing on the part of adolescents, especially in the case of girls, is often for the purpose of obtaining the "right" clothes, and the same motive is not infrequently involved in prostitution.

As to individual differences in sexual impulse, common observation of

human beings leads to the inference that there is great diversity. Experiments with the lower animals show definitely that individuals vary over a wide range in the frequency with which they will face an obstacle like an electric grill in order to reach a sex object (89, 90).

Much expression of opinion has achieved print as to differences and similarities in the sex behavior of males and of females, respectively. Scientific experiments are here again confined to infrahuman animals. Experiments conducted by the obstruction method show that males and females will cross with equal persistence painful obstacles set up to separate them from a sex object (90). Judged by such criteria, sex impulse is equally strong in the two sexes where the subjects are animals not susceptible to social ideals. In the case of human beings, sex behavior is so complicated by social pressure that inferences as to original nature are impossible. Social pressure upon girls is, of course, different from that upon boys from earliest years, because of the essential difference in reproductive function.

By original nature the young human being does not associate sex impulse with reproduction of the species. Sexual responses are not made in a state of nature for the purpose of obtaining offspring, or with that consequence in view. In this connection it is interesting to consider the ideas of primitive man. Hartland (33) believes that mankind did not discover the phenomenon of paternity for a long time. Children were supposed to be due to the magic influences of trees, rivers, rain, and sun, and of absent persons. Malinowski (54) holds that even now the Trobrianders, among whom descent is matrilineal, do not understand that men beget children. Knowledge of the causal connection between sexual response and reproduction is a matter of education, and is not provided for by original endowment, as seems sometimes naïvely to be assumed.

Novelty appears to be an important conditioning factor in sex attraction. Woodworth (99) notes the influence of this element in the following words:

> "Curiosity is, in youth, blended with the sex impulse in the first excursions into sex behavior, and in maturity as well the element of novelty in a sex stimulus gives it additional force. . . . Much of the sex behavior of young people can only be accounted for by taking into account the attractiveness of the novel and the forbidden."

Woodworth also notes the value of *uncertainty* in the maintenance of sex interest. Thus flirtation is conspicuous among adolescents as a device not only for attracting attention, but for arousing interest again where complacency has become too great through certainty of possession.

Aberrations of Sexual Impulse

It has been noted that the urge which leads to sex activity does not at first have the fixed and specific goal that is acquired in later years. The maturing but not matured organism is impelled only by vague restlessness and unspecified craving to wander and seek. The means to satisfac-

tion are not definitely and in detail visualized. If, during this stage of development, circumstances are such as to place the adolescent in a "trap situation," where no normal outlet for the emotions can be found, he or she tends to become *puzzled,* as does any animal in a trap or cage (82). Supposed methods of preventing the development of sexual impulse during adolescence, such as segregation from young members of the opposite sex, tabu, or threats, do not suppress the growth of impulse, but merely determine that it cannot achieve its biologically appropriate objects. The craving due to normal development does not cease, but impels the organism to trial-and-error activity, in the course of which any set of habits may be learned that will give release or partial release from the craving (82).

One method of release for the developing affections deprived of their natural objects is through attachment to members of the same sex. We are best able to comprehend how this form of perversion arises by noting experimental studies of infrahuman animals. Under experimental conditions in the laboratory the normal course of sex behavior has been prevented, and abnormal expression has ensued. Notable among these experiments is that of Jenkins (45), who studied the effects both of isolation and of segregation upon the formation of sex habits in the white rat by means of the obstruction method. In animals segregated for long periods, sexual responses develop toward members of the same sex within the group. With a segregation period comparatively brief, such behavior develops in some individuals, while with prolonged segregation such activity "became general."

Furthermore, in animals habituated thus to respond to members of the same sex, through the segregation method, interest in members of the opposite sex is reliably decreased when the latter are again introduced into the environment.

All of these results hold for both males and females when segregation is effected before puberty. For both sexes, in animals segregated before puberty sex activity is more often directed toward members of the same sex than to members of the opposite sex when ultimately both are made available as sex objects. Thus a young male animal, segregated before puberty with others of his sex, will typically cross an electric grill to reach another male in preference to crossing the grill dividing him from a female when the choice is offered after isolation. The same holds true for young females. Among the males thus segregated at an early age the sex drive in general appears to be subnormal (as compared with that of unsegregated males), while among females activity seems not lessened in general, but only changed in direction toward members of the same sex, rather than toward members of the opposite sex. These results have been confirmed by Warden (89) in such items as have been investigated by him independently.

In segregated schools, and at times in co-educational schools, for adolescents, the emotional phenomenon commonly called the "crush" is familiar. This is no doubt to be classified psychologically with homosexual aberrations, such as are studied in the experiments just described. The "crush"

among adolescents has received very little systematic attention from psychologists or educators (19). Ford (22) has offered observations upon adolescent girls segregated in a reformatory, made by contact and interview with inmates during their terms and by interviews with officers in charge of the institution. Finding no heterosexual outlet for their sexual drives, many girls turn their energy into love affairs with other girls. Typically, these affairs are transient, and the inmates return to heterosexual affairs after release from the institution. In this connection, it must be considered that these girls have been segregated not at or before puberty, but after puberty, and that the premature and illegal establishment of definite heterosexual practices was precisely that which brought them to the reformatory. With girls not already thus established, segregation might produce different results.

Muenzinger and Muenzinger (58) have discussed "crushes" from the point of view of the college counselor. They observe that "many who are smitten with a crush experience the temporary insanity of lovers, and do not even wish to transfer their emotions." They regard explicit instruction on this matter as a necessary part of student guidance. In the case of an affected adolescent, they advise trying to effect a change in the psychological setting, leaving change of environment as a last resort. Ford (22) suggests that a method of breaking up these attachments is to force the parties concerned into close contact with each other "till they begin to quarrel." With persons of the qualities characteristic of delinquents, this would probably happen fairly soon. The method might not succeed with persons of different quality.

Many means of finding release from craving are adopted by the adolescent, other than attachment to members of the same sex. One of the commonest of these is the manipulation of erogenous zones of his own body. Hughes (42) confirms previous investigators of the subject in finding this a common practice among adolescent boys. Taylor (79) finds that of superior men reporting on their sexual adjustments outside of marriage, a large percentage obtain release through manipulative practices. The same situation has been declared in the reports of superior women.

Space does not permit full consideration of other aberrations less common than those mentioned. These have been discussed by many students of abnormal psychology, notably by Pfister (65). Aberration could be avoided by permitting sexual drives to develop so that heterosexual mating could be achieved in adolescence. Since this seems impossible under the conditions imposed by civilized standards of living, we must perhaps agree with Russell (71), who does "not think that in the present state of society and public opinion there is any solution to this problem." Complete sublimation of sex drive, as through work or recreation, is apparently possible to few persons, even to those most capable of absorption in creative endeavors of the intellect (79).

Warden (89) has found in working with the white rat that the primary drives rank as follows in respect to strength, when measured in

terms of willingness to overcome a painful obstacle: (1) maternal, (2) thirst, (3) hunger, (4) sex, (5) exploratory. In these observations, sex stands close to hunger and thirst as a need of the organism.

The Attainment of Self-Support

In considering the adjustment of adolescents to the world's work, it is of primary importance to learn as much as possible about the way in which the differentiation of labor is related to mental endowment. From studies made up to this time, it is clear that the world's work can use nearly all grades of mentality, but that occupations vary greatly in the degree to which they are *restrictive* in respect to the amount of intellect required. Unskilled labor will at any given time show nearly all existing grades of intelligence engaged in it, whereas the learned professions will show only the higher grades. Among occupational groups tested under the authority of the United States Army, for example, the most highly restrictive occupation is that of engineering officer, in which the median intelligence rating is "A"; the least restrictive is that of laborer.

Since occupation is directly related to education, and to educational selection, existing research in this field as concerns adolescents pertains chiefly to groups at school. Psychological studies of high-school pupils and college students, as well as of continuation-school pupils, have given information of value, not all of which can be presented here.

It is clear that in the United States at the present time a large number of adolescents are pursuing studies for which they are not intellectually fit. The studies of Conklin (17), of Portenier (66), and of others (15, 26) show beyond doubt that the great influx of adolescents into secondary education during the two decades just past has brought with it many who cannot cope with the requirements. These pupils aim at occupations which are too restrictive ever to be attained by them. They present serious practical problems of mental and economic adjustment (12).

On the whole, pupils attending continuation schools are of inferior intellectual caliber (6), though the range of intelligence among them varies to the higher levels in a few cases. Private schools in eastern United States have many more than a chance proportion of intellectually gifted adolescents in them (39).

Colleges in the United States differ markedly from each other in the degrees of intellect which they select in student bodies (83). The adjustment of a given adolescent to college requirements can therefore be facilitated, if it can be known what his own capacity is, and if he can be sent to a college suited to his capacity. The range of possibilities is suggested in Figure 2.

Vocational aim in youth is likely to be determined largely on the ground of occupational prestige in a country where caste is not recognized. Lehman and Witty (48) find that the three occupations most respected by both boys and girls in the United States at present are those of physician, banker, and minister. The only occupations listed as "respected"

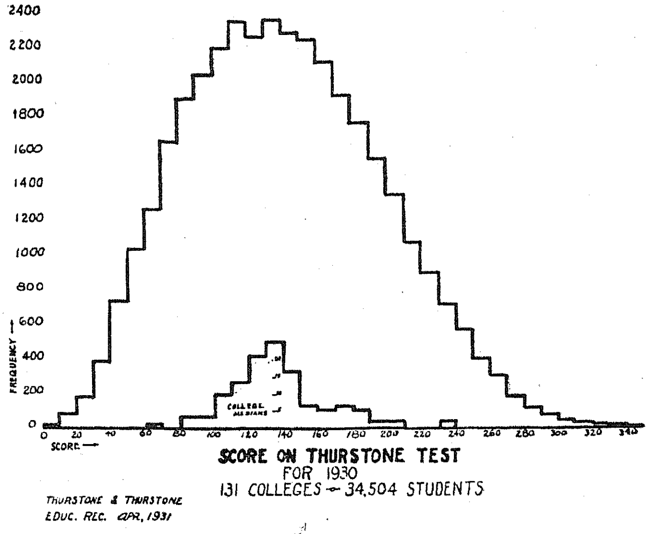

FIGURE 2

SHOWING THE RANGE OF ABILITY FOUND AMONG STUDENTS IN 131 AMERICAN COLLEGES IN TERMS OF SCORES MADE ON THE THURSTONE TEST

(From L. L. Thurstone and T. G. Thurstone's "The 1930 Psychological Examination." *Educ. Rec.*, 1931, **12**, 160-178.)

by boys and girls between eight and eighteen years of age, which call for average or less than average intelligence, were those of cowboy, policeman, sheriff, soldier, sailor, fireman, and housewife. It is a severe commentary upon the social philosophy to which the mental adjustments of adolescents must be made that the occupations to which most of them are by nature suited are not "respected" by them.

That adolescents are, on the whole, likely to be mentally adapted to the occupations followed by their parents is demonstrated by the studies of intelligence of offspring as related to paternal occupation (28). However, there is overlapping between and among various groups of offspring to such an extent that paternal occupation is not a completely reliable guide in an individual case. Some children of miners are brighter than some children of lawyers, for instance, though the overlapping between these two groups is rather small.

In the 1920 census in the United States there were listed over twenty thousand distinct and separately namable occupations, each calling for a more or less specific training and experience. The fact that the adolescent cannot under these conditions find his way alone to suitable work is recognized by common sense, and programs of guidance are being developed to assist in bringing about the necessary adjustments (5). These programs are being organized chiefly in connection with schools.

The industrial revolution whereby the factory takes care of many functions formerly carried out in the household and the differentiation of

work has made the problem of the adolescent girl particularly acute in the matter of economic adjustment. Severe mental conflicts are generated in this sphere. The vocational desires of intelligent girls are increasingly for work suited to their mental abilities (16). They do not wish to take up housework as a life-occupation, but the difficulty of reconciling mating with differentiated work is obvious. To organize the self as worker with reference to the self as mate successfully and harmoniously is one of the chief psychological problems of the adolescent girl of our day (16).

A very troublesome feature of modern life is the constant lengthening of the period of preparation for all learned professions. These requirements are now out of all proportion to the life-span, and out of harmony with organic needs. It is becoming impossible for young persons to become self-sustaining economically by means of a profession until nearly thirty years of age, if but the conventional rate of progress through schools be maintained. Psychologists are finding that the very gifted, those who are best fitted by nature for the learned professions, could easily save much time in the course of schooling. They are at present neglected in this matter (14, 39), but it would be quite possible to educate a boy or girl of IQ 140 or better so that he or she could be self-sustaining in a profession by the age of twenty-five, and could thus marry reasonably within the period of natural promptings. As matters are at present, the mean age of marriage for professional men is above thirty years, at a time when not only adolescence but more than half of the average life-span has elapsed.

In what has been said of intelligence and occupation, there is no implication that intelligence is the only important determinant of life-work for adolescents. Specialized abilities, temperaments, and other psychological equipment have not been studied as has intelligence and cannot, therefore, be discussed with assurance in the present state of knowledge.

Formulation of a Point of View

During childhood questions of origin and destiny arise intermittently and in a fragmentary fashion and may be answered satisfactorily by almost any reply made in a tone of authority. At a mental age beyond twelve, however, these questions begin to require some definite and logically coherent answer. In the primitive pubic ceremonies (60) these demands for an explanation of the universe were recognized. During these ceremonies, the youth was initiated into the moral and religious beliefs of the tribe. An explanation of the universe and of his place in it was given to him. Thus was the adolescent "confirmed" in a point of view upon life and death.

The primary part in the growing need for a religion, which culminates during adolescence, is played by the development of intelligence. Infrahuman animals, young children (except the very brightest), and feebleminded of all ages get on well enough without religious beliefs, since they do not have the degree of intellectual acumen which would enable

them to entertain questions of life, death, and moral conduct. Religion becomes a problem of adolescence, not because religious impulses grow out of sexual impulses (72) nor because a "religious instinct" emerges at this time, but because intelligence develops during the teens to a point where abstract concepts become meaningful.

It has now been established with reasonable certainty that human intelligence (in the sense of capacity for learning) reaches its maturity on the average somewhere between fourteen and twenty years of age (6, 80). It is at adolescence, therefore, that the individual first achieves his maximum power of thinking and planning. Below a *mental age* of about twelve years (the mental level typical of the average twelve-year-old child) the intelligence is not sufficiently developed to reason independently or with long-sustained effort on such subjects as the systematization of conduct or the meaning of life.

In this matter it is necessary to consider individual differences in intelligence in order to avoid the inference that religious conviction is an emotional necessity to every adolescent. The thousands of adolescents who will remain permanently below the mental level of the average twelve-year-old child cannot be expected to experience the anxieties which are involved in genuine religious and philosophical struggle. On the other hand, young children who are physically very immature begin to engage in religious struggle and are concerned with problems of origin, destiny, and conduct whenever they reach a mental level of twelve years (40). Thus children of IQ 150 begin to be troubled at about the age of eight, while those higher in the scale begin their struggles earlier. Such children are far from physical pubescence, which shows clearly that religious needs are connected primarily with intellect, and not with sex. That the needs may be complicated and intensified by the development of sexual impulse at puberty is probable, since thoughts now enter of the ultimate death of the beloved, as well as of the death of the self. Also, orthodox religion by implying or teaching directly that sex is "low" may complicate the religious problems of adolescence (18). Fritsch and Hetzer (23), studying adolescent diaries, found that the prayers of both boys and girls between the ages of thirteen and seventeen years (which is the peak of reference to religious need) are in considerable percentage for help in sex necessity and for love. Fourteen per cent of the prayers mentioned by the boys during these ages were for help in sex necessity. In consideration of data from diaries, it is, of course, essential to bear in mind that not all adolescents write diaries, and that it is not known as yet how diary writers are selected in regard to intelligence and other traits.

The age of confirmation in churches recognizes the psychological facts which have been stated (13). The age of pubescence is generally, for most organized religions, the age of confirmation.

In cases where orthodox religious explanations of the universe have been accepted, as by joining the church, and later doubt has come into play, as a result of further study, very painful emotional conflicts may

be generated. The struggle is between the emotional need to believe, on the one hand, and the intellectual impossibility of believing, on the other (3). In the words of a sixteen-year-old boy, "My hearty desire is that a God should exist, but my thinking is against it" (23). Girls seem to suffer somewhat more than boys from doubt, perhaps because they tend in the first place to be more dominated by the orthodox situation. Doubt seems to reach its peak at age seventeen and to be calmed in one way or another by the age of twenty in the majority of cases. Doubting begins with skepticism of religious *forms* and passes on to the questioning of religious *content*. Before age sixteen, 42 per cent of the mentions of doubt in diaries have to do with forms, while at and after sixteen 96 per cent of mentions have to do with content.

Specific mention is made in the adolescent diaries studied of the following subjects of *reflection*: God and man, knowledge and belief, prayer, the problem of existence, God and nature, tolerance, duties toward God. The development of altruism at this period is also evident in the greatly increased amount of reference to "others" as objects of solicitude and prayer (23).

This development of interest in "others" may lead to adolescent attempts at reform of other people or even of "the world." However, it must constantly be remembered that only a small percentage of adolescents express at any time, either in words or other acts, the impulse to reform social conditions or to convert peoples. Washburne (91) has shown that the written wishes of adolescents in general are for material possessions, adventure, play, thrills, and personal success. Of four hundred adolescents questioned, only about 2 per cent wished "to improve humanity," when asked to note what they would wish for if three wishes could be granted. Further studies of the small number of adolescents who are preoccupied with the abstract good of the human race will probably reveal that they are among the highly intelligent.

The formulation of ideas concerning moral conduct is a part of the philosophical or religious struggle. These change notably from generation to generation, so that they play a definite rôle in the problems of emancipation from the parents. Anderson and Dvorak (1) show that adolescents of today (1928) who attend college are ready for a standard of morals based on prudence and aesthetics rather than on "right and wrong" or appeals to religious authority; whereas the grandparents of these adolescents use the standard of "right and wrong" in solving most of the problems of conduct presented to them in questionnaires. The parents of the adolescents questioned occupy a place midway between grandparents and grandchildren in their tendency to refer moral problems to "prudence" or to "right and wrong." As for differences between boys and girls, these were slight, aesthetics being a little more important for the latter and prudence for the former.

Ideas of guilt and sin among adolescent workers in Germany have been studied by Kelchner (46). Boys and girls from fourteen to seventeen years

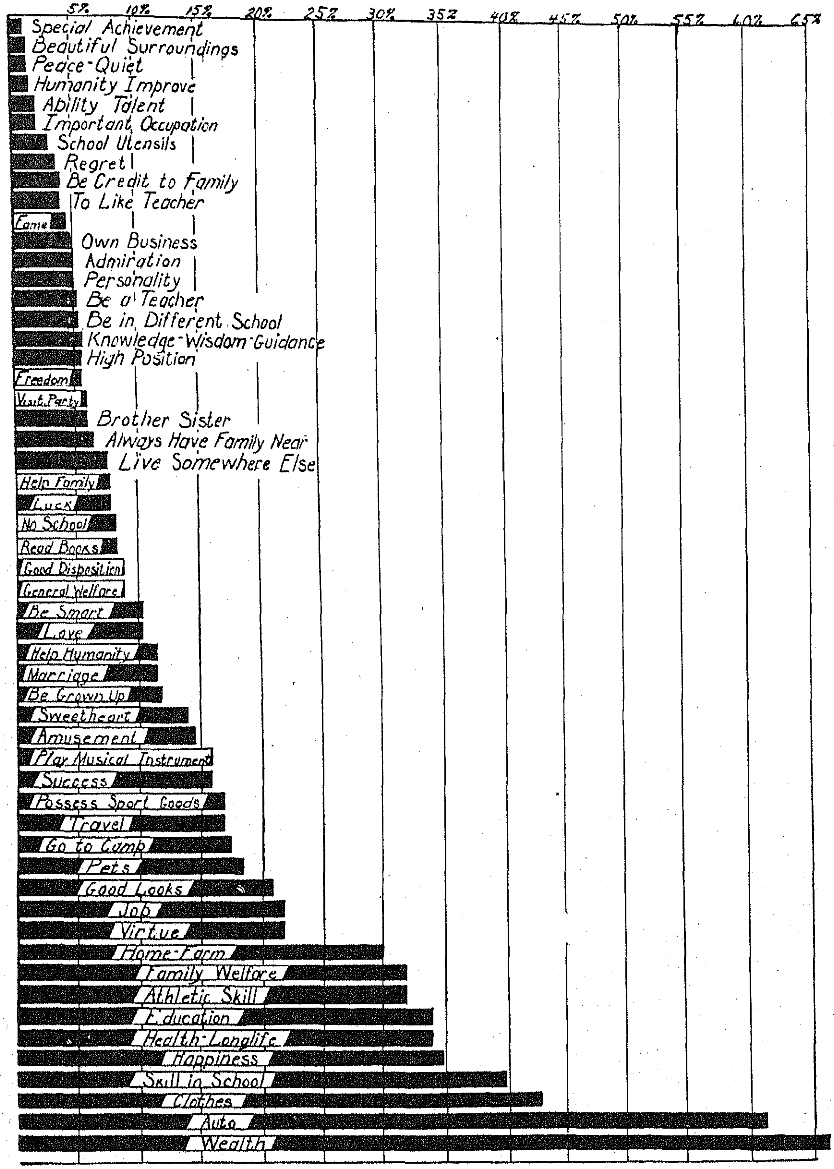

FIGURE 3

FREQUENCY OF OCCURRENCE OF WISHES AMONG FOUR HUNDRED ADOLESCENT BOYS AND GIRLS IN TERMS OF PERCENTAGE OF TOTAL GROUP MAKING THE WISH

(From J. N. Washburne's "The Impulsions of Adolescents as Revealed by Their Written Wishes." *J. Juv. Res.*, 1932, **16**, 193-212.)

of age were questioned. Great variation is found at all these ages in ideas of sin, from the naïve acceptance of the teaching that to break the law is sin to involved reasoning on the plane of ethics. However, certain generalizations can be made from the results of questioning. There appears a "will to justice" in adolescence, from which it follows that injustice rankles with particular bitterness in boys and girls of the ages studied. "The feeling for justice works in the emotional life of youth with elemental strength." The transition from school into the industrial world is also traceable in the progressively more independent opinions expressed from one age level to the next. There is a greater break between the fourteen-year-olds and the fifteen-year-olds than between any of the other levels, and the interpretation is offered that the first year out of school produces a change greater than is produced by successive years at work.

In studying the moral judgments of modern high-school pupils, Slavens and Brogan (74) found that the boys and girls between fourteen and seventeen years of age regard stealing as the worst of fifteen offenses listed for their consideration, with cheating, lying, and drinking following. Sex offenses were omitted from the list, at the request of the school authorities, and hence were not judged.

Finding the Self

The self may be most fruitfully conceived of as an *organization*, in which sets of habits pertaining to the various fundamental needs of the person function together. The adequately matured, well-integrated self is one in which these sets of habits function harmoniously and without creating chronic emotional tension. The problem of the adolescent is to organize himself into an integrated unit consisting of his occupational, racial, social, political, sexual, sartorial, and religious selves, and other minor sorts of selves. This task is very difficult, and few carry it out perfectly or completely. Many fail to such a degree as to be permanently unfit for participation in adult life. The subject is large, and space will here permit of but rather limited discussion (10, 76).

In his effort to find himself, the adolescent seeks models and ideals. He is likely to relate himself to certain stereotypes which he finds approved in his world. The choice of models is a very important element in the development of the self. The high-school age is characterized by active devotion to ideals and by the selection of traits to imitate. It follows that there is special interest in biography, fiction, and the movies during this period, and that these are important means of character formation (56). Living persons are, however, the most important models, among whom parents and teachers have special significance. The parent of the same sex has first chance to become the child's model. Next in importance to that of parents is the rôle of the teacher in the tacit guidance of the young. Adolescents' reactions to their teachers have been elicited and studied by several investigators (57). The teacher as model is often mentioned in these reports.

Even animals other than man may be emulated in their nobler qualities by the adolescent seeking models. For example, Vestal (88) in his biography of Sitting Bull writes as follows:

> "In gathering materials for this book, I tried to find out, if possible, what man or men were most admired by the youth, Sitting Bull. But none of the old men had anything to tell me on this point. At last one of them, somewhat indignantly, declared, 'Sitting Bull did not imitate any *man;* he imitated the buffalo. There was nothing second-hand about "Sitting Bull" . . . .' It was the fighting quality of the buffalo which appealed to the Teton Sioux. Courage was the most necessary virtue of their adventurous lives, and the absolutely heedless courage of the bulls struck their imagination with tremendous force. Such were the models held up before the youthful Sitting Bull."

The influence of companions of the same age is also of importance in self-seeking (96). The company kept is, however, not so much a determinant of adolescent personality as a sign of what that personality has already become, for now companions are much more likely to be independently chosen and insisted upon than in childhood. Adolescents tend to seek friends who are similar to themselves in intelligence (39) and to form groups for the interchange of experience and ideas, particularly ideas about matters upon which elders have placed tabus. Večerka (86) found that adolescent girls demand the following qualities, in the order given, in their girl friends:

> "To be lovable, that above all; to be a lover of truth; to understand; to be joyous; to have no secrets from them; to be able to keep things without telling; to be deeply attached; to be intelligent; to have established rules of conduct; to have courage to tell faults to one's face."

With the arrival of puberty comes also the need for a certain amount of solitude (86). Here the desire for the "own" room enters in (8), and the self seeks forms of expression which demand solitude at times. Such forms are found in diaries (7, 9) and in the writing of poetry (61). Day-dreams which find no expression in writing or speaking are also an aid to self-seeking (84). The nature of the real world is such that many if not most of the adolescent's cravings are denied satisfaction, for he does not yet know enough of human life to free himself from extravagant desires. Thus it is naturally the adolescent who is likely to day-dream, more than either the child or the more experienced person. Adolescent day-dreams center chiefly around love, achievement, and security.

It is surely quite evident that every adolescent has the possibility of developing into any one of a considerable variety of selves, among which choice must be made. Conflict between or among mutually incompatible selves is often a cause of emotional instability in adolescence. Different interests fight each other for possession of the available time and energy. Failure to reach a conclusion of such conflict by the end of adolescence is dangerous to mental health in adulthood, because too much of the total

time available for living is then likely to have been spent in drifting. Perception of the facts of the human life-span, and its significance for life-plans, develops during the teens, but the ramifications of this into adolescent conduct are little known. Gerard (25) found that adolescents think much about death, and take it into consideration in their life-plans.

Negativism as a phase of the effort to separate the self from what impinges on it is noticeable at adolescence. Recently Hetzer (36, 37) has suggested that there is a definite "negative phase" in girls, which she believes lasts for a few months preceding puberty (37). In this phase a tendency is alleged for the girl to be impudent to her elders, to be disobedient, and to turn to sex delinquency in some cases. Among Viennese girls studied by Hetzer, age thirteen was most frequent for first sex delinquency. This would precede first menstruation by about six months. Hurlock and Sender (44), questioning girls in New York City, concluded that only girls in poor environments show this pre-pubescent phase. Hetzer's subjects were also girls of relatively poor environment.

Negativism is best interpreted as an effort of the as yet insecure ego to win definition for itself. The crudeness of the attempt, expressing itself in impudence and other socially unacceptable forms, is due to lack of experience and of technique. Mature persons can maintain their egos courteously, because they have learned how to do so, but the adolescent has not learned. Considered thus as an attempt at finding the self, negativism is a normal phenomenon, and the lack of it is sinister. It should be met from this point of view in such a way as not to overwhelm or crush the emerging self.

In the groping process of self-seeking, certain circumstances, if they are present, constitute particularly difficult obstacles. Such a circumstance is race mixture (68). A child who has a father of a race widely different from the race of the mother is liable to peculiar confusions (34). The same difficulties are met to a lesser extent where parents speak different languages or are identified with different religions. Again, the circumstance of being a twin, of being an orphan, or a half-orphan may place special difficulties in the way of finding the self. In fact, any circumstance that tends to create a mystery or impair confidence tends to impede progress in this development. It should be understood that these influences operate also during childhood, but they do not achieve full force until adolescence, when the individual finally has to "know who he is."

Failure to Find the Self

The difficulties of self-organization are so numerous in modern life that there are obviously many chances to lose the way altogether. Failure may end in any one of a number of different forms of social disaster, the most conspicuous of which are delinquency, insanity, spurious invalidism, and suicide.

Juvenile delinquents are, as a group, subaverage in intelligence (11, 35) and emotionally ill-balanced (11). They lose their way in the struggle

toward selfhood, not because they wish to, but because they have not sufficient intelligence and stamina to organize themselves in an approved manner. Efforts at reform of delinquents who are repeaters in court during their teens are very unsuccessful (35). The prevention of delinquency is a problem calling for action in regard to the individual much earlier than adolescence.

A large amount of adolescent delinquency is due to misdirected effort at self-support. Stealing, begging, peddling without a license, prostitution, and violating child labor laws are frequent charges among those arrested. Girls are more often charged with sex offenses than are boys, not necessarily because they are more prone to unruly sex conduct, but because such conduct is thought to be more serious in the case of girls.

As a result of failure to solve his problem, the adolescent may become insane. Certain temperaments are peculiarly liable to withdraw from their problems and to evade their emotional responsibilities by retiring into a world of pretense and of day-dream (63, 73). The form of insanity thus occurring most frequently at adolescence or in early maturity is labeled in psychiatry *dementia praecox*. The early manifestations of the temperaments liable to deteriorate into *dementia praecox* are extreme reticence, seclusiveness, stubbornness, brooding, pouting, sensitiveness, suspicious attitudes, together with "odd" bits of behavior. About one-fourth of all the inmates of hospitals for the insane are classified as *dementia praecox*. An analysis by Wells (95) of a hundred consecutive cases as to their delusions and other symptoms showed very unhealthy attitudes in regard to sex in the majority of cases, and this was especially true of the girls and women included.

Other forms of nervous breakdown occurring at adolescence, such as hysteria and manic-depressive psychosis, have achieved voluminous discussion in the literature (6). The ill-balanced adolescent may not develop total social irresponsibility, and yet may suffer so much in his adult life from the failure to find himself that most of his nervous energy goes into emotional conflict. In such cases there is not enough energy left for a full and free pursuit of any adult interest.

Occasionally, the pain and depression of the losing struggle for adulthood may become so intense as to nullify all desire for life. The adolescent may prefer death to the torture of his uncertainties and may take active steps to destroy himself. Suicide among youths of both sexes is usually motivated either by disappointment in love, by homesickness, by failure in occupation, or by religious anxiety. It is the ultimate form of withdrawal from the pains of growth.

Habits of drunkenness and of drug addiction are formed during adolescence more frequently than in any other decade of life. They afford an easy means of escape from ordeals. Addiction to alcohol, heroin, cocaine, and similar drugs sometimes, no doubt, may arise from motives such as conviviality, curiosity, or desire to do as others do. However, it is no longer supposed that addicts are an unselected group of persons in regard

to original constitution. The weaker succumb, usually, it would seem, as a withdrawal from the emotional hardships of their lives.

The Meaning of Maturity

It is not easy to say briefly what maturity is (39). If maturity be defined as cessation of growth, then the human being does not mature all at once. Different parts of the organism mature at various times, typically and individually. Physical maturity, intellectual maturity, and emotional maturity must be severally considered. Moreover, each of these is a complex phenomenon.

Physical growth has been most thoroughly studied of all the aspects of development. Such measurements as have been made of stature, cranial diameters and circumference, length of finger and of other structures suggest that the human skeleton ceases to grow at about the age of eighteen years, on the average (6). However, tissues other than those of the bones may continue to develop until somewhat later. For instance, the wisdom teeth erupt typically as late as the twenty-fifth or twenty-sixth year.

As for sexual maturity, it is not yet exactly known when the reproductive functions are fully mature, on the average. We do not know at present whether the quality of the reproductive cells varies with age Also, in regards to the physiology of gestation, parturition, and suckling there is disagreement among observers, which indicates lack of sure knowledge. Opinion tends to the conclusion that sexual and reproductive functions are mature by the end of the teens.

Existing data about termination of intellectual development are inconclusive. Present evidence suggests that intelligence (capacity for learning) reaches its ultimate level at some point in middle or late adolescence. Studies so far made point most suggestively to about sixteen years as the age at which capacity for learning ceases, on the average, to increase (6, 80). From data now available it may be, furthermore, inferred that there is a positive correlation between degree of intellect and duration of the period of growth. It has been found that the very feebleminded cease to show increments of power in mental tests before they are sixteen years old, whereas adolescents of the caliber of high-school seniors still give an increment between the seventeenth and the eighteenth birthdays.

Most difficult of all is the discussion of emotional maturity (39). The course of emotional development has not been charted, though attempts to do this have been interestingly initiated recently (97). Common observation teaches that emotional control, like physical and intellectual control, grows with the years, by increments of power from within. Psychological criteria of maturity, as distinguished from immaturity, which have been suggested are (1) that the mature person is capable of *partial response,* whereas the immature gives an all-or-none reaction; (2) that the mature person can *delay* in overt emotional response, while the immature "cannot wait"; (3) that the mature person gives an *integrated response,* his emotional reaction having reference to total character, while

the child reacts in a fragmentary manner, without control from character (100).

Suggestions for Criteria and Tests of Maturity

Furfey (24) has undertaken to scale interest in activities and things as it changes from childhood through adolescence in such a way as to indicate levels of maturity. This attempt is interesting and valuable in that it permits an estimate of degree of maturity which can be referred to something more objective than mere personal opinion. At present the data relate to boys only. Lehman and Witty (47) give valuable material tending to show how various sorts of games and plays wax and wane during the period of immaturity.

Among primitive peoples fitness for participation in adult life is determined not by chronology, nor by parental opinion, as among us, but by *tests* formally and publicly applied. These tests are formulated and given by tribal representatives who have no special sentiment in regard to the novice (30). It is herewith suggested that from these primitive coming-of-age ceremonies are to be derived many clues to criteria of adulthood which might be set up as tests in modern life.

In the primitive public ceremonies we find imposed upon the adolescent in widely separated lands and tribes the following significant ordeals, among many others: to get his own food; to keep silence for a whole day or longer; to bear heat and cold without comment; to endure suffering quietly; to go alone on a strange journey; to curb appetite in the presence of food; to remain thirsty in the presence of water. When these and other tests have been passed, the youth is released by the tribe from family supervision.

For example, the ordeal of *the solitary journey*, as practiced among the Omaha of the Nebraska plains, might be scaled from birth to maturity as a test of progressive emotional development and control. Roughly and briefly, certain stages in this development might be indicated as follows: the first time the infant leaves his mother's lap or arms to sit alone; the first step alone; the first time for going alone from one room into another; the first occasion of going into a dark room alone; the first night the child sleeps away from home without members of his immediate family; the first visit alone away from the home town; the first prolonged sojourn among strangers, as at camp, boarding school, or college; the first trip to a foreign country, alone or with strangers.

Anyone who has much to do with human beings meets many persons who are chronologically over twenty-one years old who have remained at very immature levels in this scale of *ability to go alone*. There are men and women, especially women, of all ages, who cannot buy a ticket, board a train, and go with a sense of security and well-being to a neighboring town to spend a night in an unfamiliar hotel. There are adolescents who forego education because they cannot sustain the emotional ordeal of the first sojourn away from home at boarding school or college. We are

speaking here of persons who are of adequate intelligence and physique, but of inadequate emotional development.

Also, we might profitably consider the test of *capacity for silence*, as seen among the Melanesians (30). "No kind of talking or play is allowed, and the boys sit still with downcast eyes throughout the hot hours." Modern students of child psychology would agree that a characteristic of children is that they "prattle." It is childish to "tell everything one knows." When a youth has reached a stage of development markedly different from that of the "childish" in respect to chatter, he approaches fitness for participation in adult concerns. He will no longer frighten the fish or the buffalo. He will no longer betray the approach of the warrior band to the enemy by speaking aloud.

In modern life, psychologists might scale capacity for silence. Again, a few gradations might be indicated briefly. How old should a child be in order *to be able to whisper?* At what age should a child be able to see his hat blow off and *not bellow?* At what age can the average person begin to see surprising things and *utter no word?* When should the stage be past at which a person "must tell someone" immediately of his disappointment or his triumph? When is that stage of development typically reached when the person can keep silence for a whole day and night about an exciting adventure that has come within his experience? Do average adults ever develop to a level of emotional control at which a secret can be kept for a whole life-time? Or is this possible only to superior individuals?

These are questions to which answers could be given, by patient, tactful, and long-sustained research. Until such research shall have been done, it scarcely seems that we shall be in position to gauge emotional development, as we now gauge intellectual development, in order to know when a boy or girl is mature.

The major, persistent problems of adolescence are, as we have seen them, to achieve personal autonomy from the guardians of childhood, to attain self-support, to develop a heterosexual attitude, to formulate a point of view on life. When all of these major adjustments have been successfully managed, the adolescent has arrived at psychological adulthood. It is true that a person may still develop and "ripen" in regard to these matters as long as he lives; but he should have solved them in essentials by the end of adolescence if he is to enter upon adult responsibilities in a normal manner. A civilization which makes it very difficult or impossible for the adolescent to achieve these adjustments by the age of twenty-one must expect to have severe social problems of delinquency, drug addiction, and nervous breakdown.

In America today, and in other countries, these facts about adolescence in the modern world are being recognized to some extent in the guidance clinics and other agencies of counsel which are being set up to assist youth in finding the way to adulthood (81, 92).

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CHAPTER 24

THE PRIMITIVE CHILD

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The primitive child is of interest to science chiefly as an excellent subject for experiments in social psychology. By the time that primitive children become problems for pedagogues and students of juvenile delinquency, they have ceased to be genuinely primitive—i.e., members of homogeneous social groups which depend entirely upon their local oral tradition. The American Indian child or the South African child in school presents interesting opportunities for studying social change and culture contact, but is an inferior subject for the student of social psychology. In this discussion I shall confine myself to a consideration of problems centering about the child in an untouched primitive environment and the investigations to which observations on such children may be contributory.[1] Study of children in such societies presents valuable data on social psychology just to the extent to which the problem under investigation is one of the effect of social environment. There is no reliable evidence to suggest that such children differ in innate capacity from the children of civilized societies except the probable fact that the range of intellectual and emotional differences is presumably narrower, due to the smaller number of individuals who make up the society and the amount of inbreeding. The oft-reiterated statements that the Indian or the Negro child is precocious as a little child but ceases developing after a certain point are based upon the observation of such children in schools where questions of racial and, therefore, of social differences intrude with growing vividness upon the mind of the maturing child. The realization of an insurmountable handicap, coupled with an increasing discrepancy between the subjects pursued at school and the simple background of the student, may well account for such observed differences.[2]

Assuming then that the primitive child starts life with the same innate capacities as the child of civilized parents, the startling differences in habit, emotional development, and mental outlook between primitive and civilized man must be laid at the door of a difference in social environment. Investigations will therefore be fruitful in direct proportion as they seek to

[1]The student will realize that many of the same purposes may be served by careful study of children in isolated peasant communities, where homogeneity of social environment almost equal to that of a genuine primitive society may be found.

[2]No reliable intelligence tests upon really primitive children are available. The inadequacy of attempts to test school children from primitive backgrounds is excellently summarized by Blackwood (1).

study those aspects of human nature which are most subject to social influences. An investigation of attitudes towards parents will yield more than an investigation of the primitive infant's ability to follow a light or willingness to play with a red hoop; a study of the child's grasp of the linguistic categories of its language will be more rewarding than a survey of the number of words in the vocabulary of a group of two-year-olds. Primitive children should be regarded primarily as subjects in an already constructed control culture. The investigator is spared the almost impossible task of creating control conditions, but is presented with such conditions ready made. Every primitive society thus presents a laboratory to the social psychologist, in which he may test out whether certain aspects of human behavior are or are not socially determined. Observations upon children within any given culture cannot yield final results; they must be subject to control experiments of a type, which, when primitive societies shall no longer exist, will be exceedingly difficult to conduct. As the comparative psychologist never makes an experiment without controls, so the social psychologist should formulate his conclusion with direct reference to the kind of tests which investigations of primitive societies will provide. The social psychologist of the twentieth century stands in a peculiarly favored position, for the control conditions provided by these small, isolated communities which present a social picture so radically different from civilized society are still available to him.

But primitive societies, in addition to their major scientific usefulness as control social environments for check purposes, present another advantage to the student. This lies in their simplicity, their homogeneity of outlook. Also, a community which comprises only a few hundred or a few thousand individuals during several centuries will be, whatever the provisions of exogamy, inbred. Its members approximate to one type far more than is possible in countries where there are larger populations and great movements of peoples. One child in a primitive community may be presumed to have almost the same common ancestry as another. Thus a homogeneity of subjects is obtained which no amount of intelligence testing could select from among the children of even a rural district in America. And more important even than this common heredity is the homogeneity of the common tradition which must be entrusted to the habituated bodies and the memories of a few hundred individuals. Even when a wider stream of tradition is possible through division of labor or the establishment of priesthoods, the social environment with which the growing child comes in contact is extremely simple and uniform. In such an environment, differences in social circumstances stand out sharply, and the effect of primogeniture, foster parentage, order of birth, and such factors can be isolated far more readily than in our own complex societies, where no statistical calculation can do away with the thousand imponderable factors which serve to blur the importance of these conditions in the lives of civilized children.

Moreover, primitive society is characterized by a far greater formality of behavior. For example, where we leave the questions of familiarity or respect, jesting or avoidance, to individual taste, primitive society stylizes them. If one Tshi child on the West Coast of Africa is taught that it must not touch its great-grandmother's ear, every Tshi child will be found to have been taught that same prohibition. Not an individual well-trained Omaha Indian child, but all Omaha Indian children, were taught that it was permissible to help oneself to a drink in the home of a relative but not permissible to ask for water if none were in sight. Every item of behavior is patterned, and the investigator has only to learn the pattern to have a better understanding of the background of his subjects than could be arrived at with triple the expenditure of effort in a complex society. The experimental social psychologist, like the comparative psychologist, desires homogeneous material and simple conditions, with variable factors reduced to a minimum. Primitive society offers just these conditions to the investigator.

Historical Survey

The study of primitive children is, however, still in its infancy not only among social psychologists but among the avowed students of primitive society, the ethnologists. The earliest contributions to the subject were descriptive and ethnographic. The methods of the careful historian of the facts of primitive life were simply extended to include some description of the care of children, educational methods, attitudes toward children, differences in the training of boys and girls, children's games, and, perhaps most importantly, puberty ceremonials. These last were often striking, full of ritual detail and curious observance, and so far more attention was given to them than to the commonplaces of child training. Throughout the early monographs scattered observations are to be found, which, taken together, provide an impressive array of proof that the human child will flourish and absorb his tradition under most diverse and contradictory methods of treatment. They provide a working base for such comparative studies as those of Hambly (7), and the far more searching and acute analysis made by Miller (18), or a special study like that pursued by Miriam Van Waters (24); they present evidence of the diversity of the methods of human societies, but there their scientific usefulness ends. And the range of these observations also varies from mere paragraphs on "care and education of children" to careful descriptions of puberty ceremonial such as Grimble's (5) description of the Gilbert Islanders or Teit's (22) discussion of the puberty ritual of the Thompson Indians. Any comparative study which seeks to draw general conclusions from such disparate material is hopelessly handicapped.

Only two of these descriptive accounts are sufficiently detailed and well rounded to be of real value in themselves. These are *Savage Childhood,* by Kidd (10), and the description of a Plains Indian childhood contained

in Grinnell's (6) monograph on the Cheyenne. Neither Kidd nor Grinnell sought to solve any problem, but both were careful observers, and they have provided us with excellent descriptive material of two widely different systems of education.

At this point some mention should perhaps be made of the social hypotheses which have been reared upon this scattered body of facts, such as Briffault's (2) discussion of the social results of little girls' refusing to leave their mothers' sides, and Van Gennep's (23) theory of the social importance of *rites de passage,* which includes a theory of puberty ceremonial as one of ritual recognitions and softening of difficult transitions in human life. The psychologist, particularly the social psychologist, is likely to take these theories at their face value and not to inquire into the miscellaneous body of half-digested and oddly assorted observations upon which they are based. It is well to remember that there are at present only three studies (6, 10, 17) which attempt to describe primitive child-life fully and that the time for drawing any general conclusions upon the subject is not yet.

A further approach to the problem comes when the field worker not only records what he finds, but proceeds to theorize upon the basis of his own material. This method is allied to the first in that the data is simply descriptive, no attempt is made to control conditions in the field; it is allied to the theoretical discussion referred to above in that the student seeks to draw conclusions of general validity from his material. It is, needless to add, vastly superior to the first two methods, for the student deals with material of which he has first-hand knowledge and organizes it so that it has direct bearing upon general psychological problems. Radcliffe-Brown (20), in his study of the function of puberty ceremonial in the life of Andamanese youth, although primarily concerned with a study of adult society, foreshadows this approach, but the only ethnologist to employ it completely has been Malinowski (13), although he, too, was not primarily concerned with children. This brilliant study compares the "matrilineal complex" of the Trobriand Islanders with the so-called Oedipus complex of European patrilineal society, and shows how the two aspects of the European father—husband of the mother and dominant male in the life of the child—are in the Trobriand Islands disassociated, so that the mother's brother assumes the rôle of authority, while the father, shorn of all the disagreeable trappings of power, remains a loving counselor and friend. Malinowski concludes that situations of conflict such as that between European father and son, which psychoanalysts have called the Oedipus complex, are not inherent in human nature nor yet in the biological family as such, but are the results of more arbitrary and man-made conditions such as the laws of inheritance, methods of reckoning descent, and rules of residence, which distinguish Trobriand social organization from our own.

Here again a word of warning to the student who would use this latter type of material is in order. Malinowski compares our institutions and

their psychological by-products in conflict and attitudes to Trobriand institutions. By providing a test case, he demonstrates clearly that our conditions must be regarded as socially determined. One such test case is sufficient to disprove any contention that the conflict between father and son is inevitable in terms of human nature, but must not be taken as characteristically primitive, or even characteristically Melanesian. In matters of social organization, primitive society is far more diversified than is Western European society, and social psychologists, in formulating problems which may be submitted to the test of primitive society, should not do so on the assumption that the Trobriand child is *the* primitive child, or that matrilineal institutions are or have been characteristic of all primitive societies.

The next step in the study of primitive children is for the investigator to specialize upon some definite problem in the field. Not content with careful observation of such facts as come to his attention in an orthodox ethnographical investigation, he analyzes his problem—whether it be one of the relationship between physiological puberty and social maturity, the development of sex differences in behavior, or the growth and definition of personality traits—and collects material bearing directly upon the subject of research. Relevant details in each child's background are collected and the results tabulated. Where the ethnologist confines himself to a study of the child behavior typical of that society, this type of investigation studies all the minor variations about this type and seeks to trace significant variations to their sources. So a marked difference in dominating character traits among children of the same age would be followed up and traced back to its source, whether that source be difference in rank of parents, as might occur in parts of Africa; differences in composition of the family, where the biological family produced more definite character traits than large heterogeneous households, as in Samoa; or differences in the economic status of father or grandfather, as I found to be the case in Manus (17). Obvious inferiority feelings manifested by one child would be similarly investigated. If a particular age group is under observation, the preceding age group, and the one beyond, will also be studied, each member individually, to throw light upon the stage of development under observation. Such an investigator will not be content with observing children as he encounters them but will collect groups of different composition, experiment with different age and sex combinations, observe the effect of having an adult join a group, precipitate situations calling for a display of parental authority, develop sets of test conditions to which each child is given a chance to respond. He will, in short, manipulate his material, not simply observe it. He will concentrate his efforts on points which preliminary research reveals as significant.

In other words, where Malinowski, in the course of his extensive study of the adult culture, observed the typical behavior of Trobriand children and used this as contrast material to disprove conclusions based on material from our own society, this experimental child ethnologist attempts

to study not only the type child, but further to exploit the primitive child by investigating deviations within that type, as the social psychologist studies individuals within civilized society.

This experimental approach will, I believe, if pursued with the co-operation of psychologists in formulating problems, yield rich returns. I quote results obtained by this method with considerable diffidence, as they are all based upon my own field work. In my study of adolescents in Samoa (16), which, although not a strictly primitive culture, was a simple and homogeneous one, I studied not only the behavior of the average Samoan girl, but I studied every Samoan girl in the three adjacent villages, and I interpreted my results in the light of the deviant behavior as well as the average behavior. The leveling effect on personality of the heterogeneous household and the age group was checked by case where households containing only the biological family, or isolated residence, produced different results. The causes for absence of conflict in the even tenor of development of the average girl were corroborated by the turbulent histories of the few cases where these causes did not operate.

In my recent study in New Guinea, I sought to carry the methods used in Samoa a step further, and to supplement analysis and case study by actual experimental conditions. I used, of course, also the methods developed in Samoa, and the results of that part of the investigation are reported in *Growing Up in New Guinea,* which summarizes the effect on personality development of close association with adults and lack of age-group standards, the effect of a physical training in which the fumbling child is punished, not comforted, the way in which excessive physical shame inculcated early in life is later used as the society's most effective disciplinary measure, the waste motion which is involved in permitting the children an unsupervised, socially unrelated play-life, the barren, unimaginative nature of that play, the effect on the emotional development of the girls of forcing them to transfer their allegiance from father to mother, the way in which the parent-child relationship is woven into the religious life of the adult. These results were arrived at by a study of the individual against the known background, but they are the result of observation and analysis rather than of experiment. The society itself provided the necessary conditions of contrast.

My specific problem, however, was a study of child thought in an attempt to determine the rôle played by the spontaneous anthropomorphism which has been claimed to be characteristic of certain ages among our own children. I wished to see how this anthropomorphism, this spontaneous animistic thought, manifested itself in a primitive society where, far from being checked by attempts to teach scientific methods of thought, it would be encouraged by the categories of primitive thought which Lévy-Bruhl has mistakenly regarded as different in kind from our own and named *pre-logical.* I attacked this problem in several ways: by providing the children of all ages—children who had never seen paper and pencil before—with drawing paper, and permitting them to draw for four

months without criticisms or suggestions; by calling for individual interpretations of a series of ink blots; by test situations in which I attempted to shift blame upon inanimate objects or attributed will to them. I supplemented these experiments with close observation of games, group conversation, and individual child behavior. The complete account of this investigation is not yet published. It will suffice to say here that the results were most startling, the absence of anthropomorphism amazing. In not one of the 32,000 drawings was there a single case of personalization of animals, material phenomena, or inanimate objects. Due to the peculiar nature of the Manus child's linguistic and social training, the anthropomorphism which observers upon our children declared to be characteristic of a particular level of mental development, and hinted was responsible for many of the analogous features of primitive thought, was absent. This type of thought was proved to be culturally determined, a potentiality of the human mentality under special cultural conditions, but not the inevitable concomitant of any stage of mental development.

Problems for Research

Any attempt to list the possibilities of research among primitive children can necessarily only touch upon the problems involved. Every specialist presented with a summary of primitive material would see many facets of his own problem which could well be submitted to this test. I shall merely indicate, in the light of my own field experience, some of the variety of investigations which I believe would yield significant results in the fields of infant psychology, education, emotional development, and problems of child thought.

Infants and young children in primitive societies are submitted to varieties of care to which we would hesitate to subject our experimental cases. The child's head may be covered for the first three months of its life so closely that it seems in danger of smothering; it may be strapped down upon a cradle-board with hands bound to its sides; or it may be tucked into its Eskimo mother's fur hood, entirely naked. It may be taught at eight or nine months old to cling to the back of its mother's neck while she goes about her work, or it may swing perilously from her side in a loose net bag. While sedentary peoples may develop great physical self-reliance in young children, migratory peoples may have to carry children most of the time until they are several years old. Whether children are encouraged to walk will depend also upon whether an adult or a child is the nurse. Where six- and seven-year-old girls are responsible for the child care, infants may be actively discouraged from walking. Whether the child is stimulated through play is also a cultural matter. My experience has been that the greater the father's rôle in child nurture, the more playing with the baby. Mothers in primitive society are often too occupied to give the child more than necessary attention. The number of a child's nurses, as well as their age and sex, will also vary tremendously from society to society, depending upon the composition of the household, the

presence or absence of widowed and divorced women in the household, the importance of the grandmother, whether or not it is customary for women to suckle freely other women's children (which is a common custom) etc. Much will depend also upon whether little children are relegated to the background or felt to be the center of interest in a social group.

In most primitive societies of which we have any knowledge children are suckled whenever they cry; as a result infants seldom cry for more than a few minutes, unless they are sick. (Children of two and three, although still suckled, are not so easily pacified.) This suckling at any time seems to have one important result—no primitive child whom I have ever seen or heard of sucks its thumb or fingers. Those who are interested in the causes and effects of thumb-sucking would find control cases here. The problem of the prolonged suckling also offers interesting possibilities. Children are fed, of course, as well as suckled, and the mother's milk becomes steadily less nutritious. Malinowski believes that weaning at two and a half or three years old has less emotional effect upon a child than weaning at a few months of age, basing his contention on the presence of many other interests in the life of a child old enough to walk and talk. This is a theory which will bear investigation. It seems probable that the effect of his mother's bearing a new child might be stronger upon an older child whom she had suckled throughout her pregnancy, as is the custom among the Omaha Indians, for instance. The rift caused by the birth of the new baby may be an effective factor in turning the child's affection from its mother to its father, who in Manus, Dobu, and to some extent among the modern Omaha—to mention three instances known to me—because of the social arrangements surrounding birth, takes over the care and amusement of the older children. This is in contrast to the Kaffir method of ceremonially reconciling the older child to the intrusion of the new baby (14). Methods of weaning also vary tremendously—in Samoa the mothers put lime juice on their breasts, in Manus they wrap the nipple with human hair, among the Omaha the child is sent home with some other woman relative who has no milk and when it is brought home again put to sleep with its father, while in Zuni the child is mocked and shamed out of the "babyish habit."[3]

The sleeping habits of primitive children are also important. Most primitive mothers are up and at work within a few days of delivery, and usually take their young infants about with them, to ceremonies, to the garden, or the beach. When the child is sleepy, it falls asleep in its mother's arms, and as it grows older it continues to sleep wherever it is, on the prow of a canoe, laid across its mother's lap with its head lower than its body, in a half-moon position over the top of a drum, or curled into some small space between its mother and the wall of the hut. It sleeps with the sound of tomtoms and trumpets in its ears, with the shouts of the war-dance or the dismal wails of mourners sounding over its head.

[3]Dr. Ruth Bunzel, personal communication.

It learns to sleep anywhere and through anything, and from my observation I should say these sleep habits were almost wholly undesirable. The sleep of these primitive people is too heavy; too strong a resistance must be put up against interruption and discomforts; they awaken dazed, miserable, and it usually takes almost an hour to get them fully awake.

The attitude towards personal hygiene varies widely, from an extreme casualness toward excretion, as among the Samoans, to a militant prudery among many Melanesian people, which early infects the child. It is also of interest whether a child is taught care in such matters by chastisement or whether parents trust to the child's responding to their horror almost automatically. Malinowski believes that the absence in primitive society of parental solicitude over bowel-movements should do away with a child's interest in the matter, but my experience has been that primitive children retain a certain amount of such salacious interest, which may well spring, not from insistence on nursery routine, but from the prudishness of their parents. It is also of interest at what point in the child's development adult tabus regarding excretion, exposure, and use of obscene language are imposed. In Manus, small children are early subject to these tabus; in other societies there is one standard for children and one for adults.

The kind of demonstrative affection shown a child also varies from the simple Samoan gesture of running the pursed lips along the child's skin to the Manus men's habit of blowing upon a female infant's vulva. Some groups enjoin early avoidance of physical contact, even between members of the same sex; others permit a great deal. Theories of child training or character formation which involve such points could be put to the test.

The development of the type of gesture which is culturally standardized would also provide valuable material. Is there any "natural" gesture of negation, affirmation, surprise, or interrogation which can be discerned in young infants before the stamp of their society has been placed upon them? Certainly no uniformity can be found among adults of different cultures. Raised eyebrows may mean assent, disapproval, surprise, or interrogation; a thrust chin, negation; a downward movement of the arm, "come here." It is very doubtful if any theories, such as the contention that the negative head shake of our convention comes from a child's turning its head aside to avoid food, will stand when submitted to control tests. But whether these be found to be natural gestures or not, the age and way in which the conventional gesture becomes an automatic response would be interesting to investigate.

Some societies early exact rigid postural adjustments from their children. The Samoan child is taught to sit cross-legged almost as soon as it can sit at all. This one posture is the only accepted one. The baby's hands are clapped to the dance rhythm while it is an infant in arms, and as soon as it can stand it is taught to dance. Ten-year-old Samoan children are so set in the postural and rhythmic patterns of their conventions that I found it impossible to teach them so simple an activity as skipping, and sitting upon a chair for any length of time is torture to them. Manus

children, however, taught physical skill and agility, rather than any formal set of postures, could adapt themselves to new physical activities with ease.

Theories of developmental stages would also suffer serious revision if submitted to primitive tests. Not only the cruder theories of the inevitable stress and strain at physiological puberty, or of a "collecting stage" go by the boards, but many smaller variations occur. The anomalies which are present in a few of our children, such as tremendous motor development and slight development of speech; a precocious social responsibility or complete irresponsibility to an advanced age; pre-pubescent sexuality or sex experience deferred until well past puberty; friendships between members of the same sex as the result of early childhood segregation or as the result of tabus enforced at puberty; emotional dependence upon the parent broken at a few months or continuous through life, on the mother in Dobu, on the father in Manus; the development of an individualistic private existence at the age of seven and eight among some American Indian groups, deferred until well on in manhood in less religious and secretive societies: all of these variations, among ourselves attributable to special socially abnormal circumstances in an individual's background, can be found as the usual conditions for normal development in some primitive society. Painstaking study of a variety of these rhythms of social development would yield a basis upon which the extent and nature of any physiologically determined rhythm could be accurately calculated. The effects upon personality and mental ability of such divergent systems as the Samoan decrying of all precocity and the Manus premium upon a child's putting forth every ounce of effort could then be estimated. My impression from these two cases is that the Manus system, with its rewards for precocity, and close association with adults, produces the more mentally alert child. There should be other investigations to test out such hypotheses.

In the field of formal educational methods there is also a wide variety of method. Some societies, like that of American Plains Indians, trained the children through constant admonition and advice, delivered by the grandparent generation. The child was appealed to in the same terms as the adult. "People will like you if you never thrust yourself forward. If you have anything which they want they will come to you and ask you for it, if you do not push yourself." "When you are grown," the small girls were told, "build a house of your own. If you live in someone else's house you must always have your hand on the kettle ready to go for water." A Plains child's moral training, directed at his intelligence, began when he was old enough to comprehend the rewards and punishments held out to him. The Manus rely, instead, upon a child's receiving its most necessary training by the time it is three. Habits of physical proficiency, responsibility for property, personal prudery, are instilled at this early age. The Samoans permit young children to live in a state of anarchy and count upon the duties of nurse-maid for the girls, of membership in the older boys' gangs for the boys, as the socializing element.

Attitudes toward work also vary—one tribe on the northwest coast of North America loads a small girl's arms with heavy brass bracelets, one of which is removed for each domestic task which she learns; Omaha Indian parents gave away a horse the first time a small girl fetched water, or a small boy snared a bird or caught a fish; but the Samoan girl postpones finishing her fine mat because its completion will mark the end of her happy childhood freedom.

Whether the adults regard the children as small replicas of themselves, of like dignity and importance, or as social nonentities, or as a group of little nuisances, also influences the educational methods. The Plains Indians constructed for their children miniature camps, encouraged them to enact the scenes of adult life; the Samoans banish children from even imitating adult conditions and give them small tasks graded to their skill; the Kaffirs treat their children to unpleasant jobs and lies about the facts of life, and the children retaliate by developing a small outlaw state with a secret language and spy system of its own. The Manus use play only to develop physical proficiency; no attempt to instill the cultural conventions or the industrial techniques is made.

The society may encourage various types of segregation, complete sex segregation, or age standards which make it socially impossible for a ten-year-old to play with a five-year-old, or strong local feeling which makes compulsory playmates of all the children within a narrow residential area, or class differences which divide chief's children from the children of commoners, as is said to be the case in Uganda. Whichever type of segregation is set up, it will affect every child in the community; uncomplicated by the numerous factors which would enter into such conditions in civilized life, the effects upon the children may be studied. Societies which emphasize hereditary rank must give special training to the heir apparent, more democratic groups can give the same training to all. The way feelings of inferiority can be obviated either in the age-group system or the serial play group is revealing. The Samoans accomplish it by setting a premium on each member of the group approximating to the pace of the slowest, who thereby becomes socially exalted as pace-setter. The Manus method produces equally good results by setting no age standards whatsoever, and each child finds an individual niche in the elastic vertical society of the children's play group. Any sense of physical defect is disposed of in Samoa by capitalizing it in the comic dance.

These different methods of education may discourage leadership by classing it with precocity or permit it great range—as in Manus—by the wide age and size range of the group. And the ineffectiveness of childhood habits alone may be studied in the adult life, where the Samoans produce a well-ordered society by efficient political forms, while the Manus produce anarchy because they lack the political form to utilize the leadership developed in childhood.

Primitive peoples show an equally wide range of emotional development. A child's affection may be fastened upon father, mother, grandparent,

brother, or sister, or diffused over a wide group, with quite different results. Here again the point of a homogeneous society comes into the investigation. If the father is the most important environmental factor in the life of one child—he assumes in Manus the rôle commonly played by the mother—he will be so in every family in the community, and the effects of this exchange of parental functions may be studied with orphaned children as check cases.

Or a brother and sister tabu and sex segregation of children may be studied in its effect upon the later sex adjustments of adults. I believe that this type of training combined with the wide family group tends to generalize sex feeling. Such conclusions should, however, be tested out where there is the brother and sister tabu but neither sex segregation nor the wide family group—as in the Trobriands (15), and compared with the sex adjustments of individuals under conditions like those which are said to have obtained in the New Hebrides, and which von den Steinen (21) reports for Brazil, where the boys are segregated from the women and girls as soon as they are weaned. Dr. Ralph Linton has suggested to me that a strong desire to achieve marital harmony and fidelity in the Marquesas is due to the homeless, affectionless life led by the majority of the children, who roam about in gangs. This hypothesis could be tested by comparing the marital adjustments of these younger children with that made by the cherished first-born sons.

The emotional development of the child also varies as to whether the society regiments children's friendships along age, sex, rank, kinship, or locality lines, or permits the formation of intimacies according to personal tastes. Omaha children are expected to have "chums," their friendships are regarded as important by parents, who permit children to give expensive presents to their friends. And Omaha girls, accustomed to exercising choice in personal relationships, resent with remarkable violence parental interference after they have chosen a lover, although, if their affections are not yet engaged, they consent docilely enough to having a husband chosen for them. The relationship of prepubertal sex play to later sex development, whether it results in continuous marital infidelity or not, what effect such precocious stimulation has on the strength of sex responses, could also be studied comparatively.

The development of fear responses in primitive children will also reward investigation. I have found the same varying degrees of fearfulness among primitive children as among our own, but the way in which parents play upon these fears varies. The Kaffirs (10) terrorize their children with tales of horrid monsters. The Manus try to invoke evil bush demons, but the children, trained to self-reliance, physical bravery, and the experimentation necessary for effective physical adjustment to their pile-dwelling life, take very little stock in these bogey-men. As adults, they are the only Oceanic people I know of who are not afraid of the dark. The Omaha father (4) took a different course when he trained his son to court visions which were frightening but would give him supernatural power.

The child was taught to capitalize the specters of his imagination. Children so trained developed a mystical point of view, an inability to make distinctions between the real and the imagined, in strong contrast to the fearless realism of the Manus child.

Anger and jealousy are also stylized differently by different societies. The Manus child is encouraged to slap its mother, to howl with rage, whenever crossed. The Samoan child is discouraged from any display of emotion. In this case, habits developed in early childhood persist through life. All the primitive children I have studied are taught much earlier than ours to abstain from violent physical encounters, perhaps because the slender political authority of primitive societies cannot deal with strong habits of assault and battery. The Manus serial groupings has conventionalized a display of anger in a curious way. An angry child slaps the object of his wrath, who only occasionally returns the slap; instead he slaps the next smaller child, who passes it on. The anger of one child passes through the entire group like an electric current and is gone. Samoan children are permitted any amount of jealous grumbling among themselves, anger is drained off in this way, and grudges are not held for long. But the Dobuans, whose sorcery culture puts a premium upon polite lying agreement with all the other potential sorcerers, teach their children that it is dangerous not to be polite, dangerous to disagree with, to taunt, or fight, another child. Anger is given no less dangerous outlet and takes itself out in adult years in continuous murderously inclined magic, and intense jealousy.

Any student of the instincts and their social expression can formulate better than I a series of problems which should be submitted to checks such as these. I have considered that it would be more valuable to suggest, from the limited material at present available, the type of variations which the investigator might find and use to test his hypothesis.

Perhaps the most fascinating, certainly the most difficult, type of research upon primitive children is studies of child thought. This is a type of investigation which has been touched so lightly by psychologists among ourselves that the bulk of the problems remains unformulated. The first group of problems under this head might be concerned with categories, linguistic categories and the ways in which sense experience is classified by non-Indo-European cultures. The need of some such check becomes apparent when we scrutinize studies of musical discrimination, color perception, or such investigations as Piaget made into children's methods of reasoning. We need to know in what ways musical perception is subject to environment. Manus children under five or six were able to repeat a simple melody, but above that age, with the exception of one school-trained boy, they heard nothing but varying time and stress in a melody, repeating it in a monotone, quite deaf to differences in pitch. Similarly, their color classifications are so different that they saw yellow, olive-green, blue-green, gray, and lavender as variations of one color. An investigation of the other senses might produce equally bizarre results. Such

data would be of great assistance in inquiries into the relation between sense discrimination and its physical basis.

Studies of the dreams of primitive children should yield data on the types of imagery and the degree to which cultural patterns shape the dreams of young children. In Manus, children of six sometimes dream messages from the spirits—a strictly cultural pattern.

In a study of language, there are a multitude of problems. Contrasting the way in which a child learned a Malay and a Siouan or Athapascan language—the first a simple, very slightly inflected, regular language stock; the latter, languages of bewildering complexity and irregularity—would throw light on the learning process and the thought of the child. As adults, we classify languages as difficult or easy and prove our contention by pointing to the complicated structure and irregular verbs of the language listed as "difficult." But is not this relative difficulty perhaps one of relative amenableness to adult formulation, or relative strangeness of categories? If it is not so, children of different linguistic stocks should learn languages at different speeds and with different degrees of correctness. In the two studies which I have made I have found that the point most difficult for me—in Samoan the flexible use of separable prefixes and the proper use of the inclusive and exclusive pronouns, in Manus the numerous essential directive particles—were also most difficult for the children. It would be worth while to investigate the relationship between the vastly different primitive languages and the developing mental processes of the children.

In the Omaha language, the speech of the men and women differs. Male children, however, learn to talk from the mothers, and all little boys speak some woman's speech. Study of the rôle which such a point plays in the development of a consciousness of maleness might furnish interesting data.

In any attempt to apply Piaget's (19) precise research methods among primitive children, one is confronted with the absence of linguistic categories accurately defining the types of causation. Five of the words between which Piaget's subjects of different ages distinguished or failed to distinguish are all expressed by the one term in the Manus language. For the investigator there then arises the problem of the relationship between language and thought under such conditions as these.

Further types of language—the rich allusive language with many "sunken metaphors," the excessively concrete and particularizing language, or the bare, unimaginative language—all present divergent backgrounds against which to study the child's mental growth. Will an American Indian child, constrained by his language always to distinguish between direct knowledge and hearsay, be more accurate? Does the presence of formal classifications which must be expressed grammatically, or the use of a score of different sets of numerals, indicate or produce—as Lévy-Bruhl (12) insists—a different type of thought process?

There exist also interesting cases of linguistic sophistication in com-

pletely illiterate groups. Perhaps the most conspicuous case is an island in the southeastern Solomons (10) where one small group speaks the current dialect in consistent anagrams, just as if they had been spelled backwards. In a less extreme form, the Samoans, in their pre-literate days, used to reverse words, and they also used folk etymologies to provide narrative plots. In this connection it is of interest that when I tried some of the more common intelligence tests on Samoan children their most conspicuous success was in the verbal opposites test.

Children's curiosity, sometimes spoken of as "natural," can be bent and shaped by culture. Thus the inevitable "why" question is never heard in Manus. The great emphasis upon physical skill and the manipulation of material things, combined with a lack of interest in origins on the part of the adults, seems to turn all their attention to the "how," "when," and "where" type of question. My typewriter aroused no awe or fear but an intense interest in "how it works."

In areas which have a highly developed art it would also be of interest to study the way and age at which the canons of the local style became apparent in the children's drawings. Through drawing and many similar test situations, it is also possible to capitalize the inexperience of the primitive child in order to get data on relative rates of learning and adjustment characteristic of different levels of mental development. The problem of drawing a man is as new to the twelve- as to the five-year-old; differences in attack, in speed of improvement, in speed in which a stable style is established, are all apparent. This is considerably simpler than devising elaborate tests to bar out the effects of home, kindergarten, and school training among our sophisticated children.

In this brief discussion I have only attempted to suggest some of the varying aspects of contrast and comparison which primitive society presents to the student of child psychology. The subject could only be exhausted were all the problems of psychology formulated and all the cultural variations in existence known. Meanwhile these small, untouched societies are rapidly being invaded and missionized and what work is to be done must be done within the next twenty-five years.

Planning Research

Since the field is practically unexplored, it seems appropriate to conclude with a few comments upon planning research. The student should have training in both anthropology and psychology, with an emphasis in psychology upon social, child, and abnormal psychology. Experience in psychiatric case work, especially among children, or in teaching, will prove more valuable than a knowledge of laboratory methods and equipment which it is almost impossible to use in the field. The anthropological training should emphasize particularly work in social organization—analyses of kinship systems, a sufficient knowledge of primitive religion to familiarize the student with the alien concepts which he will encounter,

and a good training in linguistics. (The ability to learn language quickly and a high memory span for nonsense material are perhaps the two most necessary native abilities for this type of work.) A detailed knowledge of the ethnography of the area chosen is also necessary. A student whose training is primarily in psychology but who wishes to study some special problem would be wise to choose an area which has been well described ethnologically, for example, the Trobriand Islands, or the Andamans. The choice of an area which has already been described has also the advantage that the conditions will be known, the problem can be phrased in advance in terms of the culture.

For those, however, with a broader ethnological training and interest, other cautions hold. There should be no attempt to choose the exact area in advance, beyond the necessary choice of an English, Dutch, French, or Spanish colony, in terms of the European language spoken. Unless the problem is specifically concerned with linguistics, care should be taken to choose an area where the language is not difficult, as it may make several months difference in getting to work, without any difference in the rewards. But the final choice of a working location must be made from nearby, and be based upon exact information concerning the size of the community and the residential arrangements. For example, a detailed study of children could not be made in Dobu, where each village comprises only ten or fifteen people, and the members of each village are hostile to the members of other villages. Cultural attitudes towards children should be ascertained, if possible. For most purposes, it is better to work in a region where children are regarded as the most natural interest for adults than in a place where a man of rank is never supposed to speak to a child. A male investigator should try to find a region where the fathers play an important domestic rôle. A woman investigator should attempt to discover the native attitudes toward barrenness and marital status in relation to their power of bringing good or bad luck to children, and then disclose herself as single, widowed, divorced, the mother of twins left with their grandmother, or whatever fable is most likely to give the natives confidence in her. Students of problems related to art or industry should inquire in great detail as to how much of the observable material culture is local, how much traded in.

I shall conclude with a word about the kind of problems which should not be attempted. These are: problems which require a large number of cases; problems which require exact ages; problems which require family histories in detail; problems which call for a narrow age range; and problems which call for laboratory conditions of complete freedom from interruption or the use of apparatus. Under primitive conditions none of these requirements can be met. Before the investigator can give the baby a set of blocks to play with he must conciliate the child's parents. After that, there is still the baby to win over. This takes time, propinquity, patience. An investigator of very young children can only count upon the children fairly close to his place of residence, shifting his

residence about produces strain, suspicion, and discord, which are bad for the work. Primitive people never know their ages, and narrow age range means too few cases in a village.

But within these limits, there are numberless aspects of social psychology upon which a year's research in primitive society would throw light. If we avail ourselves of this opportunity, we shall go far towards constructing a realistic psychology, corrected and informed by a detailed knowledge of the power of the social environment, a psychology which transcends the narrow bounds of Indo-European culture.

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